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## PRIMARY CARCINOMA OF THE LUNG

REPORT OF A CASE OF PRIMARY CARCINOMA OF THE UPPER LOBE OF THE  
LEFT LUNG, TREATED SUCCESSFULLY BY LOBECTOMY, AND  
SUBSEQUENT THORACOPLASTY

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IT HAS long been recognized that successful surgical intervention in primary carcinoma of the lung is very rarely possible. Secondary carcinoma is, of course, out of the question so far as surgical treatment is concerned. But even primary carcinoma, for several reasons, seldom admits of surgical cure.

The number of recorded cases of successful surgical intervention is very small indeed. Lenhartz had one successful case in five—an infiltrating type of carcinoma, in which almost the whole lung was excised piecemeal, the wound being left open, and submitted afterwards to systematic X-ray treatment. The wound ultimately healed, and the patient lived for two and a half years. Morriston Davies, in 1919, reported a case of lobectomy of the lower lobe of the right lung for primary carcinoma. The patient did well for six days, but then developed an empyema, from which he died. More recently, in the October number of the *British Journal of Surgery*, 1933, J. E. H. Roberts and H. P. Nelson have reported a case of squamous-celled carcinoma of the lowest lobe of the right lung, in which lobectomy was carried out successfully November 5, 1932. The case was a somewhat doubtful one, and, indeed, a chronic abscess was suspected rather than a tumor growth, but operation disclosed a free lower lobe, which admitted of ready removal. It was not until after it had been removed that the diagnosis was actually made. The patient is reported as having been very well six months later.

Sauerbruch, Walzel, and a few others have also reported cases of successful surgical removal either of an affected lobe of the lung, or of varying portions of lung substance—by ordinary surgical means, or by surgical diathermy, by itself or combined with irradiation.

Until comparatively recent years, there were very few records, in the surgical literature of this country, of cases of primary carcinoma of the lung diagnosed during life, and, even in respect of autopsy records, statistics were very meagre and unsatisfactory. Thus, Playfair and Wakeley, writing in 1923, were able to find only three cases reported in this country during the five years immediately previous; while in America more than thirty cases had been recorded within the same period. They made a thorough search of the clinical and pathological records of King's College Hospital from

1901 to 1923, and were able to find only four clearly established cases out of 3,183 autopsies—representing 0.12 per cent. of primary carcinomata of the lung at autopsy in a large London teaching Hospital, over a period of twenty-two years. Other authorities put the figure a little higher—even up to 0.5 per cent. of all autopsies, and about 5 per cent. of all deaths from carcinoma.

While the corresponding figures today, in respect of autopsy findings, would probably be very little higher than the King's College Hospital figures, the number of cases actually diagnosed during life would be considerably larger than at the time Playfair and Wakeley's paper was written. None of the four cases described by Playfair and Wakeley had been diagnosed at a stage sufficiently early to permit of radical surgical intervention. Within the last few years, much more attention has been given to the subject, and, as a result, not only are cases nowadays being diagnosed at an earlier period than formerly, but they are less likely to be confused with other conditions—such as tubercle, or chronic abscess of the lung—than they formerly were.

The two most important impediments in the way of successful surgical treatment of primary carcinoma of the lung are: (1) the relative infrequency of a localized tumor being situated well out in the lung parenchyma; and (2) difficulty and delay in diagnosis.

As regards the first of these factors, it is well recognized that in probably over 90 per cent. of all primary carcinomas of the lung the disease originates in the region of the hilum, and spreads thence simultaneously into the lung, and into the mediastinum, so that effective surgical extirpation is impossible. It would appear to be unlikely that, by presently known surgical methods, any considerable effective surgical attack can be made upon this 90 per cent.

As regards the second factor, considerable advance has undoubtedly been made already, for cases of cancer of the lung are being much more frequently diagnosed, and at a much earlier period, than even a few years back. The chief advance in this respect is probably to be ascribed to improvements in X-ray investigation, and to new applications of X-ray methods.

One may hope, therefore, that, out of the 10 per cent. residuum, an increasing number of cases may in the future be recognized at a stage early enough to permit of radical intervention, with some hope of cure. Even here, however, one may have the disappointing experience—as the present writer has had on two occasions within the last two years, *i.e.*, subsequent to the date of the case reported in this paper—of making a relatively early diagnosis of a localized peripheral primary carcinoma of the lung, only to find, when the lung was exposed at operation, that there was already an extensive chain of invaded glands, reaching from the lower part of the hilum right up to the arch of the aorta; rendering what would have been, otherwise, a comparatively simple extirpation of the affected lobe, quite futile. In one case, the primary tumor was situated in the lowest lobe of the right lung, and the whole lung was quite free, so that its extirpation would have been associated with no great difficulty. In the other case, the tumor occupied the lower





PLATE B.—Section made in *sagittal* direction. Note.—(a) Marked encapsulation of the tumor; (b) Its antero-posterior disposition within the lobe of the lung.



PLATE C.—*Pleural* aspect of the same sections as in Color Plate B. Note.—Thickening and puckering of the pleura.



## PRIMARY CARCINOMA OF LUNG

lobe of the left lung, and the affected lobe was completely free from adhesions, so that there would have been no considerable technical difficulty in its removal. In a third case, about six months ago, the lowest lobe of the right lung was also involved, but, though the symptoms and signs of pulmonary disturbance had been of comparatively short duration, the tumor had already invaded the pleura, spread well up into mediastinum, and was extensively plastered over the surface of diaphragm, so that its extirpation was out of the question.

In view of what has been said above, the following case seems worthy of being put on record.

*Primary Carcinoma of the Upper Lobe of the Left Lung, Treated Successfully by Lobectomy, by Trap-door Thoractomy, Supplemented Later by Thoracoplasty.*—H. M., a man, forty-two years of age, a caisson sinker, was admitted to the Western Infirmary, Glasgow, on January 13, 1932, to the wards of my colleague, Professor T. K. Monro. He had been seen previously at the out-patient department of the Infirmary by Dr. J. A. W. McCluskie, who suspected he might have a malignant condition of the lung; and an X-ray examination made at this time showed a definite shadow in the upper left chest, which suggested tumor.

The man had been invalided home from West Africa in September, 1931, by reason of rheumatic symptoms following upon a severe wetting he sustained in June, 1931. On admission to hospital, in January, 1932, he complained of pains and stiffness in the knees, ankles and other joints. His legs had been first affected. Later, his wrists and fingers became involved. The affected joints were swollen and tender, and it was noted that his fingers and some of his toes showed marked clubbing.

A systematic examination was made of his chest, abdomen, rectum, optic fundi, and urine, and the throat and nose were specially examined with a view to finding any active septic focus—all, at first, with negative result. The Wassermann reaction was negative, as also was examination of the blood. The temperature was irregular—occasionally slightly febrile. Pains in the joints varied considerably. There was at first no cough, but a slight cough developed later on. Various medical remedies were tried, including salicylates, quinine, iodides, protein shock, *etc.*, but gave no relief.

A further careful X-ray examination of the chest was made. This confirmed the presence of a rounded shadow in the upper part of the left chest. (Fig. 1.) The mass indicated by this shadow seemed to lie posteriorly, under cover of the scapula. It was not clear, at first, whether it was attached to, or growing from, the chest-wall, or was in the substance of the lung. In order to clear up this point, artificial pneumothorax was induced by Dr. James Crockett on March 26 and 28 when it was found, on subsequent X-ray examination, that the rounded shadow had fallen to the lower part of the chest cavity. (Fig. 2.) It was clear, therefore, that the mass was in the substance of the lung, and, further, that it was not adherent to the chest-wall.

About this stage, a small nodule was noticed in the left breast. This was slightly tender to touch, and on April 11 it was excised, and submitted to pathological examination. It proved to be of a simple nature, the report

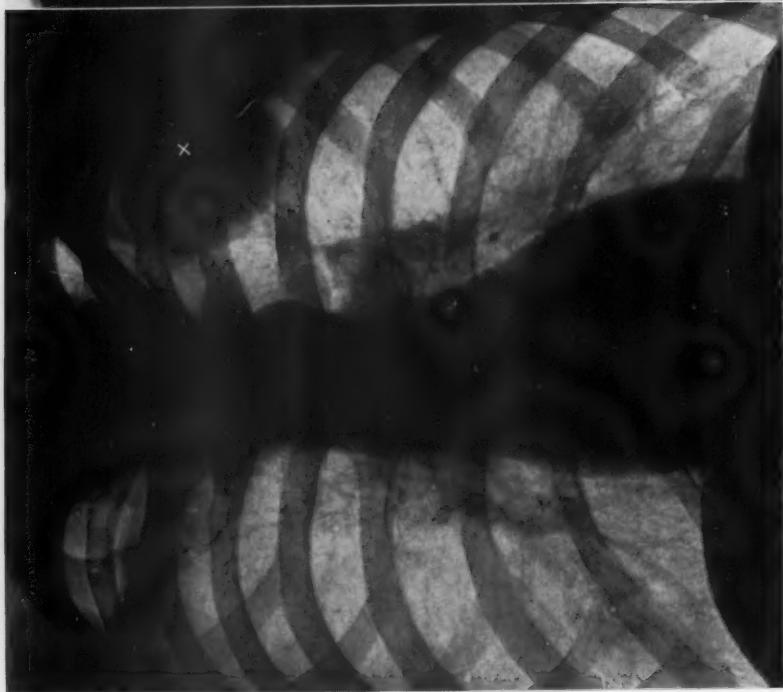


FIG. 1.—Radiogram, March, 1933, Note shadow of tumor in upper left chest.

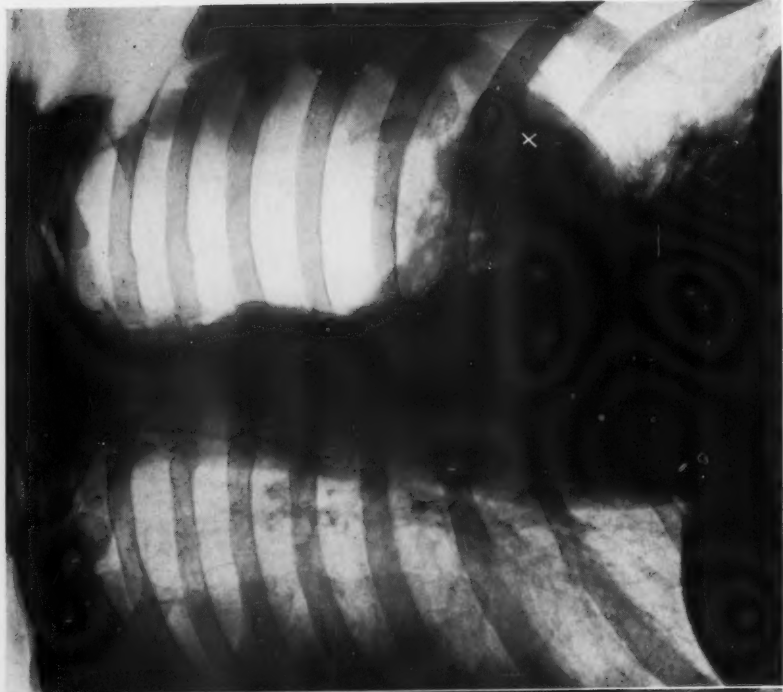


FIG. 2.—Radiogram, April, 1933, Note tumor shadow displaced downwards, after artificial collapse of lung.

## PRIMARY CARCINOMA OF LUNG

indicating that the breast was the seat of "chronic inflammatory change, with early cystic degeneration." Obviously, it had no significance in respect of the intrathoracic lesion.

The man was transferred to my charge April 25, 1932, with a view to surgical intervention. When admitted to my ward, the patient's general condition was fairly good. The left lung appeared to have expanded again to a considerable extent, and the respiratory murmur was vesicular in type, vocal resonance being equal on the two sides.

*First Operation.*—May 4, 1932. *Trap-door Thoracotomy; Lobectomy.* Anæsthetic—intratracheal ether-oxygen. The left chest cavity was laid open by the reflection of an oblong flap, including the fifth, sixth and seventh ribs, which were divided at the anterior and posterior ends of the flap (trap-door) incision; the base of the flap was posterior. The osteoplastic flap was turned backwards, the pleura being at first maintained intact. (See keys to Fig. 4.)

The pleura was then incised widely, when it was found that the lung was partially collapsed, and that the upper lobe contained a mass, roughly spherical in shape, and about the size of a tangerine orange. This mass felt of solid consistence, and the visceral pleura overlying it was slightly puckered and depressed in several places; but there were no adhesions to the parietal pleura.

The region of the left vagus, external to the root of the lung, was "blocked" by the injection of 2 per cent. novocaine, and the two lobes of the lung were then carefully separated from each other. The *entering arterial branches* (on the outer aspect) to the upper lobe were systematically ligated, and divided, one by one, and the upper lobe was then turned outwards, to expose the *issuing venous branches* (on the inner aspect), which were similarly ligated and divided.

The lung tissue was then cleared from the entering bronchus, which was clamped, ligated, and divided, the whole upper lobe of the lung, with the tumor, being thus removed completely.

The stump of the bronchus was touched with pure carbolic acid and spirit, and an endeavour was made to invaginate it, and to cover it over with parietal pleura. It was realized, at the time, that it might have been better to leave a small portion of lung tissue to cover the stump more effectively. There was practically no bleeding during the intrathoracic part of the operation, and very satisfactory access was obtained through the trap-door opening. The reflected flap of chest-wall was replaced and carefully sutured, without drainage—but the isolated segments of the three ribs were, at the last moment, enucleated, and taken away altogether.

*After-course.*—For about a fortnight, the man's general condition continued quite satisfactory. Pulse and temperature ran a normal course, and examination of the chest seemed to suggest that the lower lobe of the lung was expanding steadily, and promised to fill the greater part of the cavity, leaving only a limited apical pneumothorax, which—it was hoped—might remain aseptic. This hope, however, did not materialize, for, about two weeks after the operation, and following upon somewhat too vigorous respiratory movements during examination, there developed pain in the chest, followed by moderate febrile reaction and renewed cough. Signs of a limited apical pleural effusion became evident, and it was clear that drainage would require to be established.

*Second Operation.*—May 25, 1932. *Excision of eighth rib for drainage.*—On May 25, 1932, *i.e.*, three weeks after the operation, a further rib (the eighth) was excised, for the purpose of drainage, and exit was given to a small quantity of thin, blood-stained fluid. A drainage tube was sutured in position. (See keys to Fig. 4.) Thereafter, the patient's general condition improved substantially, but the uncollapsed pleural cavity continued to discharge. It may be said that the fluid originally withdrawn from the



## ARCHIBALD YOUNG

chest was submitted to bacteriological examination, but no organisms were found, either in films or on culture.

*Third Operation.*—June 25, 1932. *Thoracoplasty.* In view of the persistence of discharge, it was decided to carry out a thoracoplasty, so that the walls of the cavity might fall together. On June 25, 1932, this was done. A long J-shaped incision was made in the line of the fifth rib, and the upper four ribs were removed subperiosteally and extrapleurally. (See keys to Fig. 4.) The trapezius and the latissimus dorsi were divided along the vertebral border of the scapula, the rhomboid muscles being also divided posteriorly. The serratus magnus was stripped from the ribs anteriorly, and the exposed upper four ribs were then excised, from their angles behind to just short of the costochondral junction in front. The wound was sutured in layers, without sepa-

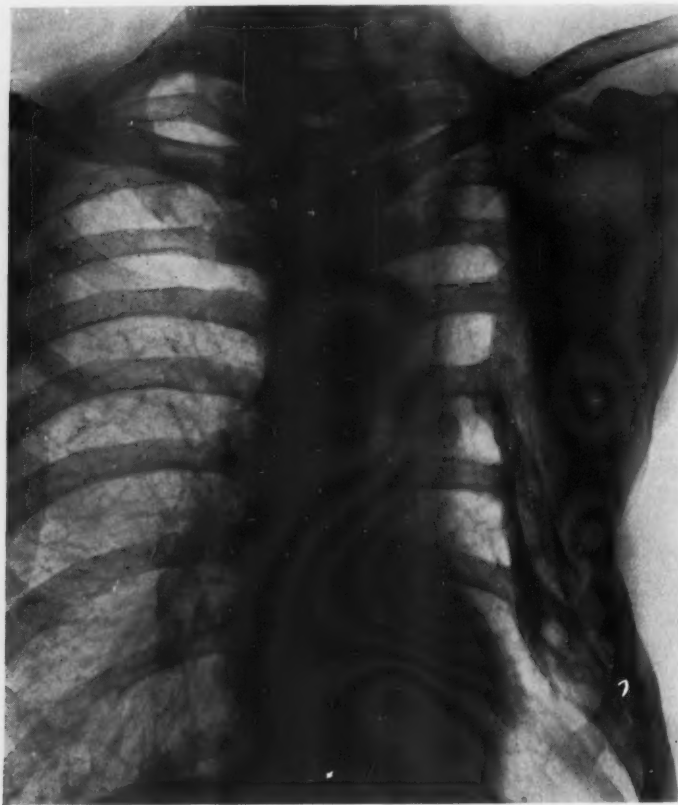


FIG. 3.—Radiogram, January 5, 1934, one year and eight months after lobectomy. Note (a) the considerable, uniform contraction of left pleural cavity; (b) the considerable regeneration of the upper eight excised ribs.

rate drainage, the original drainage tube below being, however, left *in situ*, to drain the apical pleura.

*After-course.*—Following this operation, the patient continued to progress favorably, and his convalescence was uninterrupted by any untoward happening. He was dismissed from hospital August 5, 1932, *i.e.*, three months after his original operation, and six weeks after the thoracoplasty. His wounds were by this time well healed, and his general condition was good.

He reported from time to time as an out patient. On September 1, 1932, he was seen. His general condition was excellent. He stated that he had occasionally slight pain in the region of the left costal margin. The lower lobe of the left lung seemed

## PRIMARY CARCINOMA OF LUNG

to have expanded effectively, and the respiratory murmur and vocal fremitus were both good, though not quite equal to the right side.

On various occasions from September, 1932, to May, 1933, equally satisfactory reports were obtained, and on May 17, 1933—i.e., a year after operation,—the following note was made:

Patient is in excellent health, and he has wonderfully free use of his left upper limb. The deformity of the chest-wall is much less notable than one might have anticipated, and a good deal of new bone has developed in the whole region from which the ribs were removed. This gives stability to the over-lying muscles. Further, the lung on the affected side seems to be functioning efficiently, as a careful examination of the chest shows.

The patient has been seen since on several occasions. He was seen on January 5 of this year, 1934, when local and general conditions were satisfactory in every way. He was in good health generally, was free from pain, and had excellent functional use of his left upper limb. At this date, a further radiogram of his chest was obtained. (Fig. 3.) It showed that the left lung cavity was considerably and uniformly reduced, and that there had been a considerable amount of regeneration of the excised upper eight ribs.

The latest occasion on which he was seen was on March 31 of this year, when it was again noted that local and general conditions were satisfactory in every way. On this occasion, photographs were obtained, which illustrated well (1) the comparatively slight deformity of the chest; and (2) the extensive range of movement of the left upper limb. These are reproduced in Fig. 4, which includes also keys indicating the lines of incision of the successive operations.

*Pathology of the Excised Lung. Preparation of Specimen.*—Immediately after the operation (lobectomy), on May 4, 1932, the main entering bronchus of the excised lobe was injected with Kaiserling fixing fluid, and was ligated. A small quantity of fixative was introduced also into the entering branches of the pulmonary artery. The whole specimen was then immersed in a bath of the same solution.

After two days' immersion in this solution, gross sections were made. The first incisions were made in a plane approximately parallel to the coronal plane, in such a way as to traverse the hilum, and to divide the tumor across its greatest diameter. Two comparatively thin slices were removed in this way, one of these slices being presented to the department of pathology; the remaining slice, and the rest of the tissue, being retained in the possession of the department of surgery. From the two other portions of the lung a slice was removed by a sagittal cut, in order to show the actual antero-posterior disposition of the tumor.

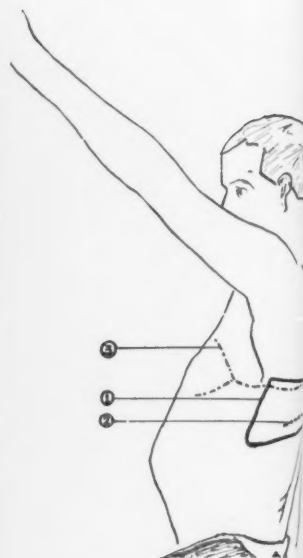
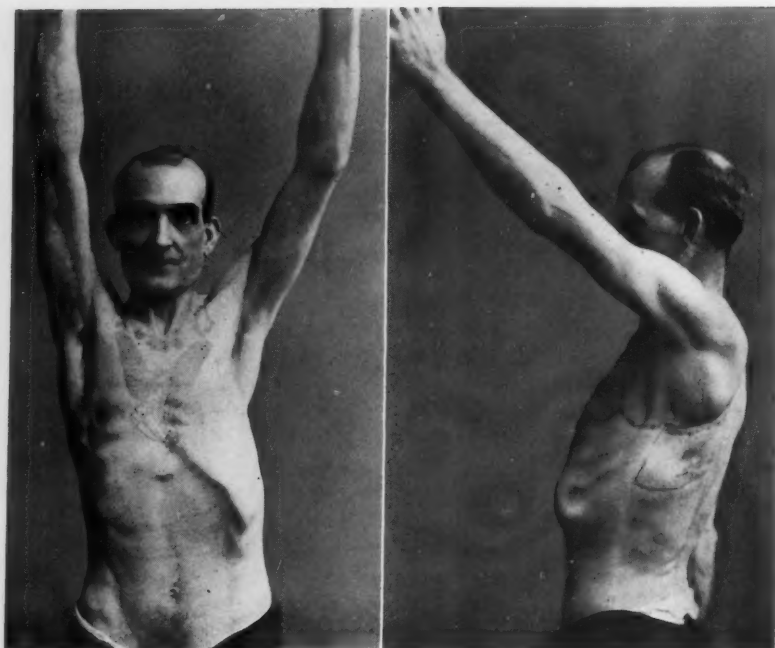
*Gross Appearance of Specimen.*—On the upper, outer, and anterior surface the pleura was thickened, and the surface was somewhat depressed and puckered immediately over the position of the tumor. Toward the lower margin of the lobe, on the external aspect, there were a few filmy tags of adhesion, which had been divided.

The general appearance and topography of the tumor are well brought in the color drawings. (See Color Plates, A, B, and C.)

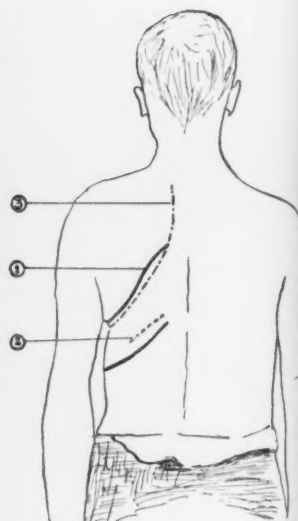
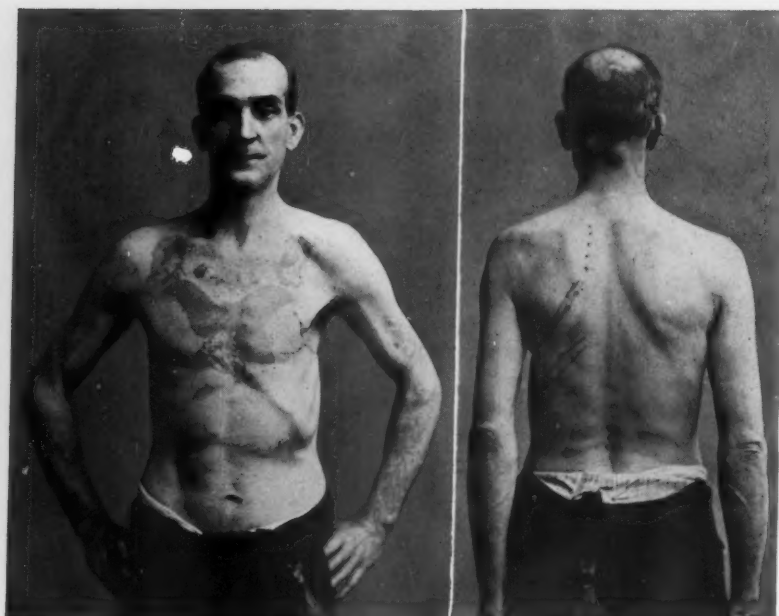
Reference to the color plates will show that the tumor is in the form of a short ovoid, conforming fairly well with the shape of the upper half of the pulmonary lobe, and approaching very closely to the pleura at the place where, as noted already, the pleura was thickened and puckered. The margins of the tumor are well defined, and the general outline lobulate. Running directly into the lower medial aspect is a large branch of the pulmonary artery, accompanied by a bronchus of similar size. The exact relation of the latter to the tumor is not, however, apparent in the planes of section used.

The tumor has a generally whitish color, with a good deal of anthracotic shading. Centrally, it is largely necrotic, and of a somewhat grumous, atheromatous consistence. It tended to wash out under the tap. The peripheral portions of the tumor are, however, well preserved, and consist of firm, solid tissue of a somewhat pink color,

ARCHIBALD YOUNG



- (1) ——— Trap-door Thoracotomy  
(2) - - - - Thoracostomy (drainage)  
(3) - - - - Thoracoplasty.



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(2) - - - - Thoracostomy (drainage)  
(3) - - - - Thoracoplasty.

FIG. 4.—Photographs March 31, 1934. (Almost two years after lobectomy.) Note (a) the comparatively trifling deformity of the chest-wall; (b) the wide range of elevation and abduction movements of the left upper limb; (c) the scars of the successive operations. (These are indicated in the accompanying keys.)

## PRIMARY CARCINOMA OF LUNG

apparently fairly well vascularized. There is no recognizable naked-eye evidence of a neoplastic infiltration along the pulmonary artery or bronchus, and no lymph-nodes are apparent at the hilum.

*Preliminary Report on Histology of the Tumor.*—A preliminary report on the histological structure of the tumor was obtained May 10, 1932 (six days after excision of the affected lobe). This preliminary histological examination was carried out by Mr.

FIG. 5A.

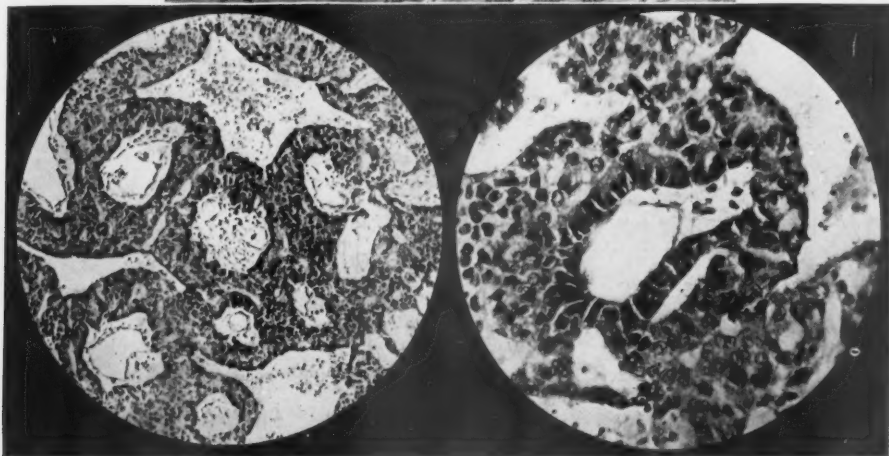
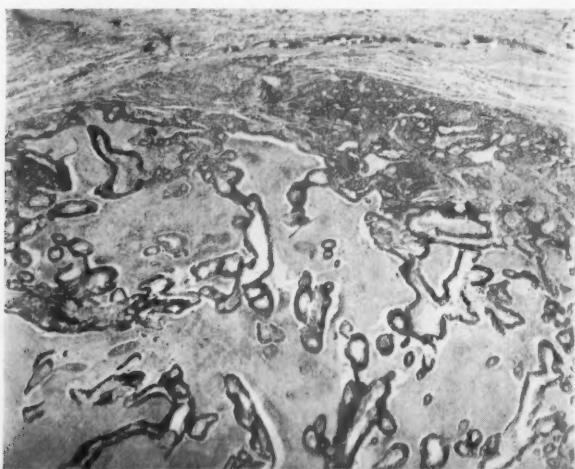


FIG. 5B.

FIG. 5C.

FIG. 5A.—Margin of tumor. ( $\times 11$ .) Note (a) False Capsule of Compressed Lung Tissue Surrounding Tumor; (b) Histological Simulation of Adeno-carcinoma. FIG. 5B.—( $\times 80$ .) Note close network of thick strands of spheroidal cells, many layers deep, and with a somewhat alveolar arrangement. FIG. 5C.—( $\times 250$ .) Note (a) masses of closely packed spheroidal cells; (b) tall columnar cells, resembling bronchial epithelium, arranged in palisade fashion around a blood-vessel.

A. Ian L. Maitland, Hall Fellow in Surgery, attached to the Department of Surgery, who reported in the following terms:

This is a carcinoma of the lung, of alveolar type. The tumor appears to be surrounded by a pseudo-capsule of condensed lung tissue, in several sections examined. In all the sections, a considerable degree of necrosis is present.

*Final Report on Histology.*—For a final, full, and complete report on the histology of the tumor I am indebted to Mr. W. A. Mackey, one of my Assistants in the Department of Surgery. His report is as follows:

## ARCHIBALD YOUNG

The central portion of the tumor is completely necrotic. The cellular structure is preserved satisfactorily only in a comparatively narrow zone at the margin. In this region the tumor shows a considerable degree of vascularity, but, even so, the tissue of the tumor survives only as a broad sheath of cells, growing in a pseudo-papillomatous fashion round the arterial branches, and divided up by masses of degenerated, desquamated cells. The interlacing of these cellular bands produces a false superficial resemblance to an alveolar carcinoma.

Cytologically, the tumor presents remarkable uniformity in structure. There are two principal types of cell. The first is approximately spheroidal, and the cells of this type are disposed in closely aggregated sheets, many cells deep. They have large, pale, vesicular nuclei, and show numerous mitoses. The second type of cell is larger, cylindrical or columnar in shape, and has a large, oval, hyperchromatic nucleus. Cells of this type tend to occur in a palisade arrangement round the smaller arterial branches. In some parts of the tumor, thin cellular layers, composed entirely of cells of this type, are met with, but frequently they constitute merely the basal layer of the masses of pale spheroidal cells already described. While it is not possible to be absolutely dogmatic regarding the histogenesis of this tumor, there seems to be justification for suggesting that the resemblance of the columnar cells to the lining epithelium of bronchi would support the view that the carcinoma is of bronchial origin.

The histological appearances described in Mr. Mackey's report are illustrated in the photomicrographs included in Fig. 5, A, B, and C, prepared by Mr. John Kirkpatrick, of the Department of Pathology.

*General Summary.*—(1) A case of successful lobectomy for primary carcinoma of the lung is described, and is illustrated in the several figures, and in the color drawings.

(2) Reference has been made to the small fraction of operable cases, and this would seem to justify the full description of this somewhat unique case. It is gratifying to be able to record that, two years after operation, the man is fit and well.

(3) The type of operation followed here, namely, trap-door thoracotomy, proved in every way satisfactory. It gave excellent exposure, and the utmost freedom to the operative technic of removal. In subsequent cases, referred to in an earlier part of the paper, the trap-door method of exposure was not employed, the chest being opened in the more usual way by wide separation of the ribs. It was felt, in these cases, that there would have been definitely less freedom in manipulation had excision been feasible.

(4) The individual ligation of entering arteries and returning veins seems, where practicable, to be preferable to mass ligation of the stump as practiced by many operators today. It is questionable whether this procedure of individual ligation need add materially to the duration of the operation.

(5) The chief difficulty would seem to be in respect of the effective closure of the bronchus, but this difficulty should be readily enough overcome if a small portion of lung tissue is left, which may be closely sutured over the crushed, ligated, and inverted stump of bronchus.

NOTE.—At the several operations, in this case, I was fortunate in having the assistance of Mr. A. J. Hutton, First University Assistant attached to my department, and Assistant Surgeon to the Western Infirmary. I desire to acknowledge his help and coöperation, not merely in connection with the operative procedures, but also in the subsequent treatment of the case.



## THE STUDY OF THE MORPHOLOGY OF THE WHITE CORPUSCLES OF THE BLOOD IN THE PROGNOSIS OF OPERATIONS\*

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OF LENINGRAD, U. S. S. R.

ORTHOPEDIC CLINIC OF PROFESSOR R. R. WREDEN

THE rôle of the state of the blood in the course of the post-operative period has been long known and is connected with the notion of the so-called "organic resistance of the organism against infection." Indeed, investigations have shown that the surgical wound, which heals *per primam*, can by no means be bacteriologically sterile and an uncomplicated post-operative course entirely depends on the properties of the tissues. It is generally known how badly tissues heal with people suffering from diabetes, arteriosclerosis, anæmia, leukæmia; on the other hand, with a number of people with no definite somatic deficiencies, any operative interference results in suppuration. This complication is thought to be due to a decreased organic resistance of the organism, but the essence of this resistance long remained unestablished and only in 1911 two Italian physicians, Lerda and Rossi, in examining the morphology of the blood in 100 cases of clinically sound people, previous to their being subjected to herniotomy, quite incidentally discovered a connection between the condition of the blood and suppuration. Namely, among the nine cases which resulted in suppuration seven proved to have had increased leucocytosis and eosinophilia before the operation.

The rôle of the condition of white blood has been long since estimated in surgery and many authors have suggested various "methods" of examining blood. By the term "method" one should here understand merely this or the other "interpretation" of the picture presented by the white corpuscles of the blood as connected with the clinical picture of the disease, *i.e.*, with its diagnosis and prognosis. The authors, chiefly surgeons, tried to establish certain types and numerical values of the leucocytal formula, to which the dominating importance on the struggle against infection was attributed. Thus arose the methods of Wolff, Zangenmeister, Hans, Federmann, Arneth, Kohl, Koshe, Sondern, Schilling, Kozlowsky, *etc.*

For clinical purposes it is essential that the application of the method should be simple and that it should provide objective data. These requirements are duly fulfilled in the method of the New York surgeon, Sondern, who published in 1904-1905 a series of his works on hæmatology. He advanced two statements:

(1) Inflammatory processes show an increased percentage of polynuclears in the blood—the degree of this increase corresponds to the severity

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\* Read before the Leningrad Surgical Society.

of the inflammatory process and is an indication of the intoxication of the organism.

(2) The high leucocytosis which is observed here is merely a symptom of the degree of the resistance shown by the organism and by no means an indication of the intensity of the pathological process.

For diagnostic purposes Sondern stated that 85 per cent. of polynuclears in adults was the sign of an accumulation of pus or of gangrene: for those of prognosis—he noted the co-relation between the numbers showing leucocytosis and those of polynucleosis and the direction of the so-called Resistenz-Linie in the hæmatological scale he established.

Sondern's method has been later made applicable for children by Doctor Kozlovsky who, on the ground of a large number of blood examinations (6,000), introduced the following changes and corrections:

(1) He included into the number of nuclears a group of mononuclear granular elements (myelocytes) and substituted the term polynucleosis by that of neutrophilia.

(2) He introduced four age scales as applicable to children: for the age of four years, neutrophilia = 36 per cent.; to seven = 46 per cent.; from eight to ten = 52 per cent.; from eleven to thirteen = 60 per cent. with a leucocytosis of 8,000 uniform for all ages.

(3) The diagnosis of the presence of pus or of gangrene was approximately established for every age, when neutrophilia was increased by 25 per cent. as compared to that normal for the given age.

(4) He also introduced the notions of various conditions of blood:

(a) Normal condition of blood for a given age.

(b) Pyæmic condition—leucocytosis of various height and neutrophilia up to 85 per cent.

(c) Septic condition—leucopænia and neutrophilia above 85 per cent.

(d) Septico-pyæmic condition—leucocytosis of various heights and neutrophilia above 85 per cent.

*Clinical Observations.*—In Professor R. R. Wreden's clinic the examinations of the morphology of the blood of patients entering for operations have been carried out. They were performed chiefly for the purpose of establishing the clinical value of the picture of the blood in cases of surgical interference. The methods of examination applied were those of Sondern-Kozlovsky; occasionally, for the sake of comparison, examination was also carried out according to Arneth's and Shilling's methods.

We shall now say a few words with regard to the technic of the method. Every blood examination was carried out on an empty stomach, between 9-10 A.M. The blood was taken from the soft tissues of the finger. It was collected into Potain's solution to the level of 0.5 and was then dissolved on 0.5-1 per cent. solution of acetic acid. The test was dyed according to Giemsa's and Main-Grünwald's staining methods.

For the determination of the leucocytal formula, about 200 corpuscles were usually counted. In cases of a pathological blood condition the number counted was increased to 400-600 corpuscles. The counting was carried out in four different sections of the test to avoid errors due to a non-uniform distribution of leucocytes within the test.

The total number of examinations carried out on patients subjected to various operations was 500. The largest number of examinations of the blood of one and the

## MORPHOLOGY OF WHITE CORPUSCLES OF THE BLOOD

same patient was over 20. The morphology of the blood was studied both previous and subsequent to the operation. In cases when the blood was not normal before the operation, the examination was repeated; in cases of post-operative complications the examinations were continued during the whole period of the patient's feverish condition, until the blood became normal. The patients, whose blood was examined the day before the operation, were chiefly orthopaedic cases, who but for some deformation or other, were clinically sound people, with a normal temperature and an absence of any inflammatory processes.

In other cases the anamnesis showed some affliction of the joints, which had resulted in either ankylosis or contracture of the affected joint; the temperature was normal, no pains could be observed in the joint, and the cessation of the process had rarely occurred less than a year ago. It was established that when patients were operated on having a normal blood condition, the post-operative course was as a rule not followed by any complications. Contrary to this, if patients were subjected to an operation when their blood was not normal, post-operative complications were very frequent, and were often accompanied with the phenomena of a general intoxication of the organism and a local suppuration of the surgical wound which healed by second intention.

In the process of study, several formulæ of abnormal blood conditions which might give rise to post-operative complications were established:

(I) The abnormal blood condition characterized by an abnormally increased leucocytosis, increased neutrophilia, markedly granulated protoplasm of neutrophiles, the presence of an increased number of dissolving cells and trombocytes, a decreased (as compared to the normal) percentage of eosinophiles or even their total absence.

The anamnesis of patients with the above-given blood formula showed that the patient had been recently subjected to a light infection (cold in the head, sore throat) or had suffered from toothache one or two months previous to entering the clinic. Sometimes the anamnesis failed to provide any definite data. Thus, though the patients were clinically sound and with a normal temperature, the process had apparently not yet ceased, notwithstanding the absence of any clinical symptoms, and the blood indicated to the presence of a continuing infection in the organism.

Our observations coincide with those of Dr. A. A. Kozlovsky who states that the post-operative course in patients with the given blood formula is as a rule followed by complications—suppuration within the region of the wound, and not infrequently a general septicopyæmic process.

The total number of patients, with the given blood formula, who developed complications was seven.

	Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes	Post- operative Course
1. L. B., age 17....	11,000	74 %	20 %	5.5%	0.5%	0 %	Complication
2. L. B., age 17....	10,000	73 %	17 %	9.1%	0.4%	0.5%	Complication
3. E. A., age 12...	12,000	74 %	20.6%	5 %	0.4%	0 %	Complication
4. G. Z., age 5....	15,000	54 %	36.2%	6 %	3 %	1 %	Complication
5. G. Z., age 5....	14,000	58 %	26.3%	14 %	1.2%	0.5%	Complication
6. P. A., age 22....	7,000	75 %	18 %	6 %	0.5%	0.5%	Complication
7. S. N., age 26....	11,500	80.5%	10 %	6.5%	2 %	1 %	Complication

An increased leucocytosis alone, when the leucocytal formula is normal, does not produce, according to our observations, any complications subsequent to operations, if it is but temporary and is due to some casual cause (muscular movement, emotions, the effect of indigestion, etc.). Similarly, neutrophilia varying between 73-75 per cent., with no granulation of the protoplasm of the neutrophiles and a normal leucocytosis

# F. T. ARVANITOPULO

and eosinophilia, may be but the result of a technical error in counting the test. Therefore, in evaluating the picture of the blood, it is necessary to take into consideration several components and the greater their number the greater the probability of a post-operative complication. Several short histories of disease follow:

CASE I.—Patient F. A., aged fourteen years. Entered the clinic October 4, 1926. *Diagnosis*—Pes equino-varus. *Anamnesis*—Was first taken ill ten years previously. Complaints of not being able to walk. *Status Præsens*—Nutrition satisfactory. A small trophic ulcer of the skin in the region of the Achilles' tendon. This is surrounded by a cicatrix—the result of a former elongation of the Achilles' tendon. Somewhat increased nervous excitation.

November 13.—Operation: Cicatrix removed; tenotomy of the Achilles' tendon; wedge-like resection of the foot.

Beginning with the second day temperature rose to 39.1°; on the third it was 39.4°–40.2°. A septic-pyæmic process, with chill, ensued. Test shows the presence of diplococcus. Condition serious. An abscess in the region of the external malleolus was incised on the twelfth day. Temperature became normal after six weeks.

Blood condition previous to operation:

Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes	o t
12,000	74%	20.6%	5%	0.4%	0%	36.8

there we have—leucocytosis, increased neutrophilia, with granulation of the protoplasm of neutrophiles, eosinopenia and a large number of dissolving corpuscles.

CASE II.—Patient S., aged twenty-six years. Entered the clinic December 4, 1926. *Diagnosis*—Ankylosis celsiti dextra; blood examination previous to operation; leucocytes, 7,800; neutrophiles, 63.5 per cent.; lymphocytes, 25.5 per cent.; monocytes, 5.5 per cent.; eosinophiles, 5 per cent.; basophiles, 0.5 per cent.

December 20.—Arthroplastic of the joint. Plaster-of-Paris bandage for two weeks in an extended position. Bandage removed after two weeks. The arm was easily bent under anæsthesia to 85°. Wound showed no signs of inflammation. An inconsiderable discharge of blood.

Picture of blood previous to redressation:

Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes
11,500	80.5%	10%	6.5%	2%	1%

The post-operative course of the disease was complicated by high temperature (over 39°) and suppuration in the region of the wound.

Here we have increased leucocytosis, increased neutrophilia, granulation of neutrophiles and a large number of dissolving cells.

Thus, even a bloodless redressation produced complications.

(2) Either by neutropenia, not infrequently followed by granulated protoplasm of neutrophiles (the phenomenon of a shift to the left according to Arneth's scale) or by an increased—as compared to the normal—lymphocytosis (from 35 per cent. and more), monocytosis, eosinopenia, a large number of dissolving cells and Jürk's irritation leucocytes. The greater the number of components simultaneously observed in this formula, the greater the probability of post-operative complications.

Increased lymphocytosis and monocytosis usually indicate the existence of some chronic inflammatory process, which irritates the lymphoid apparatus

# MORPHOLOGY OF WHITE CORPUSCLES OF THE BLOOD

of the organism. In these cases the inflammatory process is usually not very severe (the lympho- and the monocytal phases in the struggle of the organism against infection as defined by Shelling); the adherents of a different theory consider this relative increase in the percentage of lymphocytes to be the consequence of a decreased number of neutrophiles due to intoxication of the organism. (The phenomenon of leucocytolysis according to Manuhin, Botkin, Kozlovsky, *etc.*) However, it may be theoretically stated *a priori* that patients with the given blood formula will bear a surgical interference far worse than those having a normal blood formula, and will more frequently have post-operative complications. Practice has indeed entirely confirmed these theoretical postulations.

The total number of patients with the given blood formula, *i.e.*, with increased lymphocytosis and monocytosis (neutropenia) who had post-operative complications was twelve.

Thus, with the given formula we still had, though less frequently, a series of post-operative complications, and one of them even proved to be fatal.

If we select the cases where lymphocytosis and monocytosis are above 45 per cent., and of such there were ten, we see that four of them resulted in complications; namely, the higher the relative percentage of lympho- and monocytosis, the greater the probability of a post-operative complication.

Several histories of disease follow:

CASE I.—Patient K. S., aged fifty-five years. Entered the clinic on October 2, 1926. Died on December 5, 1926. *Diagnosis*: Ankylosis coxæ dextra. Operation—arthroplastic of the hip-joint. Complication—diplococcus. On the ninth day, delirium; pulse, 135; respiration, 45; no discharge from the wound. Died with symptoms of increasing weakness.

Blood previous to operation:

	Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes
	6,500	57.5%	38.5%	5.5%	4.5%
Last 2 days be- fore patient died	11,200	96%	2%	2%	0%
	7,200	98%	2%	0%	0%

According to Arneth, a shift to the left by 69 per cent. According to Schilling, a shift to the left myelocytes.

CASE II.—Patient S. F., aged twenty-two years. Entered the clinic on October 2, 1925. *Anamnesis*—In May, 1924, a purulent inflammation of the left knee-joint. Was subjected to three operations. Last wound healed in December, 1925. From the beginning of 1926 the leg began to become contracted; redressation under anæsthesia, but later the leg again returned to the former position. *Status Præsens*—Nutrition good. Heart-tones somewhat dull. Lungs, occasional dry râles. Immobility of the left knee-joint. No pains in the joint. Temperature normal.

*Diagnosis*—Ankylosis genu sinistri. Operation—arthroplastic. Course of the disease: October 6, slight cough; October 9, no cough. Temperature invariably normal. October 13, operation. From the second day, temperature 37.3°–38°. Patient feels fairly well. No pains in the leg. On the fourth day severe headache, slight pain in



F. T. ARVANITOPULO

	Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes	Dissolv. cells	Post-operative Course
1. K. S., age 55....	6,500	57.5%	38.5%	5.5%	4.5%	0%		Exitus letalis
2. O. S., age 15....	9,300	53%	39.5%	4%	3.5%	0%		Suppuration and general intoxication
3. D. A., age 22....	8,200	61%	35.5%	3%	0.5%	0%		Suppuration, necrosis of the skin-flap
4. F. V., age 26....	7,400	42%	51%	5.5%	1.5%	1%		Pneumonia; suppuration on twelfth day
5. S. F., age 23....	7,200	47.5%	42.5%	5%	2.5%	2.5%		Suppuration
6. H. F., age 32....	7,200	51%	30%	17%	2%	0%		Complication
7. B. V., age 18....	7,800	50%	41%	8%	1%	0%		Suppuration
8. S. A., age 20....	6,800	54%	42.5%	3.5%	0%	0%		Suppuration
9. V. V., age 10....	7,200	40%	53%	5%	2%	0%		Complication, with suppuration and general in- toxication
10. S. V., age 24....	8,900	59%	36%	3%	1.5%	0.5%		Complication, with suppuration and general in- toxication
11. M. V., age 27....	9,000	58%	37%	3%	1.5%	0.5%		Suppuration
12. S. F., age 22....	12,000	52%	41%	7%	0%	0%		Complication, Re-ankylosis

## MORPHOLOGY OF WHITE CORPUSCLES OF THE BLOOD

the joint. On the fifth day a chill and further atypical septicopyæmical process with a rise of temperature to 39.9°. The process lasted for seven weeks and further the temperature remained subfebrile during three months.

The picture of the blood previous to operation:

Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes
12,000	52%	41%	7%	0%	0%

Here we observed increased leucocytosis, granulation of the protoplasm of neutrophiles (with a shift of the nucleus to the left according to Arneth's scale), a complete absence of eosinophiles and many dissolving cells. End-result, re-ankylosis.

On March 3, 1927, the patient again entered the clinic.

On the part of the lungs, the right apex is somewhat flattened; respiration of this apex somewhat harsh; patient suffers from a productive process of the right apex. February 8, operation—arthroplastic. Further, a post-operative complication with suppuration in the region of the wound.

Blood previous to operation:

Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes
7,200	47.5%	42.5%	5%	2.5%	2.5%

CASE III.—Patient F. V., aged twenty-six years. Entered the clinic on Dec. 27, 1926. *Status Præsens*.—In the apex of the right lung a cirrhotic process. *Diagnosis*—Spondylolisthesis V lumbalis. Operation: Fixation of spine on January 11, 1927. From the second day a rise of temperature up to 40°, with phenomenon of bronchopneumonia in the bronchi; on the fifth day incision of the hæmatoma. From sixth to tenth day dressings of the wound, which is sterile. On the tenth day suppuration in the wound. Tests contain diplococci.

Blood previous to operation:

Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes
7,400	42%	51%	5.5%	1.5%	0%

CASE IV.—Patient B. A., aged eighteen years. Entered the clinic on February 17, 1927. *Diagnosis*—Spondylolisthesis Lumbalis. v. 22. II. Operation: Fixation of the spine. Hæmatoma with subsequent suppuration and healing of the wound by second intention.

Blood previous to operation:

Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes
7,800	50%	41%	8%	1%

Here we had increased lymphocytosis. It is of interest to note that a similar operation was simultaneously performed on another patient, with a normal condition of the blood. This patient also had a post-operative hæmatoma, which healed, however, by first intension.

(3) Finally, the blood formula, when, instead of a normal leucocytosis 6,000–9,000, there is a decreased number of leucocytes.

Leucopænia, in such cases, particularly so if it is simultaneous with the preceding blood formula (lympho- and monocytosis), only aggravates the prognosis of a surgical interference.

Usually an infection introduced during an operation is rapidly eliminated by a sound organism, due to a sufficient amount of resistant powers. In

# F. T. ARVANITOPULO

cases of leucopænia, when due power of resistance is considerably decreased, this proves not infrequently sufficient—owing to a weakened reaction of the organism—to produce complications, which are the more severe, the more considerable the trauma and the introduction of the infection from without. Besides, it should be noted, that leucopænia sometimes precedes the development of a disease on the organism. In Professor R. R. Wreden's clinic, observations over patients with the given blood condition showed that they were subject to complications with severe clinical symptoms, with phenomena of a general intoxication of the organism, which in some cases proved to be fatal.

The total number of cases suffering from leucopænia, which produced complications, was three. Among them two resulted in death and one produced suppuration.

	Leuco- cytes	Neu- tro- philes	Lympho- cytes	Mo- no- cytes	Eo- sino- philes	Baso- philes	Operation	Post- operative Period
1. S. I., age 24 . . .	4,200	55%	38%	6%	1%	0%	Arthropology of hip-joint	Exitus leth- alis
2. P. A., age 25 . . .	4,800	49%	29%	21%	1%	0%	Fixation by Albee's method	Exitus leth- alis
3. V. N., age 32 . . .	4,900	59%	35%	5%	1%	0%	Plastic	Suppuration

One history of disease follows:

CASE I.—Patient P. A., aged twenty-five years. Entered the clinic on December 20, 1926. Died on January 23, 1927. *Diagnosis*—Spondylolisthesis Lumbalis V. 18. January 27, operation: Fixation of the spine. From the second day temperature, 40.2°; pulse, 125° and 140°. Condition bad. In four days' time hæmorrhage from the wound. Wound sterile, no pus. Post-mortem examination: t. b. c. miliaris lobi superiocius pulmoni sinistri. Enteritis follicularis acuta. Pyelitis purulenta.

Blood previous to operation:

Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes
4,800	49%	29%	21%	1%

Here we had a case of leucopænia, and simultaneously an increased number of monocytes (neutropenia).

The blood indicated the presence of a favorable chronic process (t. b. c. pulmonis). Besides, we observed that there was a marked decrease of the resisting powers of the organism.

The total number of complications observed on 500 operated patients was twenty-eight; among them three cases where the morphology of the blood was unfortunately not known.

In twenty-two cases out of twenty-five the blood condition was abnormal; in the remaining three it was normal:

	Leuco- cytes	Neutro- philes	Lympho- cytes	Mono- cytes	Eosino- philes	Baso- philes	Post-operative Complication
1. B. M., age 24 . . .		71 %	24.5%	3%	1%	0.5%	Exitus lethalis
2. G. M., age 30 . . .	7,900	68.5%	24 %	5%	2%	0.5%	Necrosis of the skin
3. B. N., age 20 . . .	7,200	60 %	26 %	7%	7%	0 %	Necrosis of the skin

## MORPHOLOGY OF WHITE CORPUSCLES OF THE BLOOD

We see that in one case death ensued on the second day after the operation. The post-mortem examination showed that it was caused by anæsthesia (status thymico-lymphaticus—an abnormal endocrine formula according to Professor Oppel). In the second and third cases there was necrosis of the skin-flap, caused by technical error (non-satisfactory nutrition plus too firm suturing).

The third patient developed tetanus (cause unknown) a month after the operation and was removed to a hospital for infectious diseases.

Thus, we see, that among 400 operated cases, with a normal blood formula, complications occurred only in three, which amounts to 0.75 per cent.: *i.e.*, the least percentage of complications occurs when the condition of the blood is normal.

All the above-stated facts and considerations serve to explain why certain operations cause no complications in some patients, while they are followed by complications in others, notwithstanding a high surgical technic and the fulfillment of all the requirements of antiseptics.

It seems necessary to conclude that complications in cases when the blood condition is normal—namely, when the powers of resistance of an organism are sufficient and there is no endogenous infection—are probably the result of technical errors during the operations.

On the ground of the observations carried out in Professor R. R. Wreden's clinic we take the liberty of making the following conclusions:

(1) A study of the morphology of the blood proves to be indispensable for every surgical interference.

(2) A normal blood condition is the ideal time for an operation, as it warrants a favorable result and a healing of the wound by first intention.

(3) Operations, when the blood condition is abnormal, produce, with a certain regularity, post-operative complications.

(4) A pyæmic condition of the blood, characterized by increased leucocytosis, increased neutrophilia, with marked granulation of the protoplasm of neutrophiles, together with eosinopænia, or a total absence of eosinophiles, an increased number of thrombocytes and a large number of dissolving cells, is a contra-indication to a "sterile" operation, as it often results in complications.

(5) Operations are contra-indicated in cases of leucopænia, as this is a symptom of a decreased power of resistance of the organism, and such operation may produce complications, which not unfrequently prove to be fatal.

(6) Surgical interference in cases of lymphomonocytosis (neutropænia) may produce post-operative complications, and therefore in making a choice between a complicated and more simple operation it is desirable to give preference to the latter.

(7) An examination of the morphology of the blood is the best clinical method for determining the resistance of the organism in case of an operation.

## THE USE OF FASCIAL AND TENDON GRAFTS IN CERTAIN FRACTURES AND DISLOCATIONS

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IT WAS in the War period, 1916, that the idea of reconstructing some of the ligaments of the joints by means of strips of fascia or tendons first occurred to me and I was able to devise the operation for reconstruction of the crucial ligaments of the knee-joint which has with various modifications been adopted by many surgeons in recent years. During the last eighteen years many occasions have arisen to use this operation and also to devise similar ones for the repair of other injured joints. It will be more orderly if the operations are described in anatomical sequence rather than in the order in which the various procedures were devised.

*The Jaw. Temporo-mandibular Joint.*—Internal derangement of this joint is fairly common, but many patients, who suffer from it, do not consider their symptoms serious enough to justify an operation. Recurrent dislocation of the jaw is comparatively rare but is a distressing affliction, for when once the patient has become liable to it she knows that if ever she indulges in a really good yawn the joint will dislocate and then she is helpless until the dislocation is reduced. It is obvious that to prevent dislocation without fixing the joint something must be done to prevent the head of the jaw slipping forward. This might be done by building a bone block on the zygoma, just in front of the socket. But this would be difficult to do and more difficult to get to consolidate. The other alternative is to tie back the neck of the jaw by means of a tendinous check. In the first case I did, the patient was a woman of fifty-two, who had been suffering for many years. The dislocation was bilateral and she was so pleased with the result of the operation on one side that she came back three months later to have the other side repaired.

The operation consists in anchoring the neck of the jaw backwards to the mastoid process, using one of the tendons from the forearm as a free graft. The incision is made horizontally below the ear and need not be more than one and one-half inches long. The auricle should be pulled up in making the incision so as to cut at a level higher than that of the facial nerve. By blunt dissection the neck of the jaw is exposed, turning back the overlying parts of the parotid gland. By means of an aneurism needle a passage is secured right round the neck of the jaw. (Fig. 1.) At the posterior end of the incision is the mastoid process, which is perforated near its apex by means of a twist drill  $\frac{3}{16}$  inch in diameter in a direction from behind inwards and forwards. A piece of silk ligature is passed through the hole in the mastoid and round the neck of the jaw, in order to measure the length of the tendon required. This is then cut from the left forearm, taking by choice the tendon of the palmaris longus or if that is poorly developed the brachioradialis. The



## FASCIAL AND TENDON GRAFTS IN FRACTURES

tendon is passed round the neck of the mandible and through the hole in the mastoid and the two ends pulled tight and sewn together with linen thread. No special after-treatment is required and the patient need not stay in hospital more than a few days.

*The Shoulder. Recurrent Dislocation.*—It is notorious that many operations have been devised and practised for this condition, a fact that is

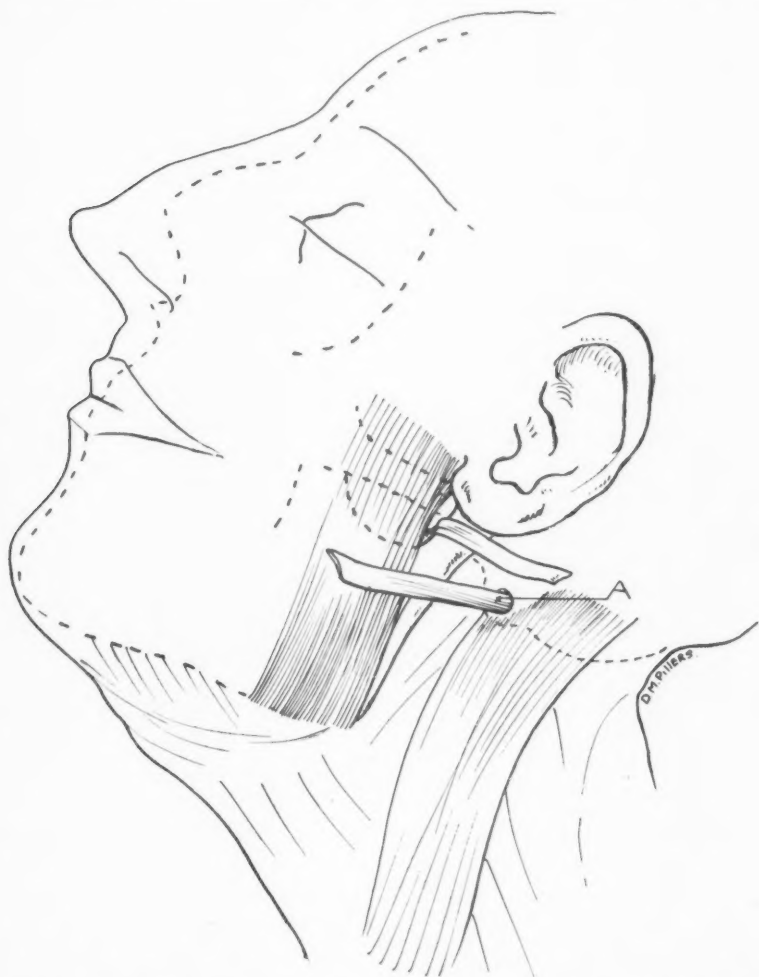


FIG. 1.—Diagrammatic dissection of the neck, showing tendinous sling round the neck of the jaw. (A) Hole drilled in mastoid process through which the tendon is drawn. (The parotid gland and facial nerve are not shown for clearness' sake; in the operation the former is drawn forwards and the latter lies too deeply to be seen.)

significant of the difficulty of the problem. I had practised many of these operations before I devised the one which I am about to describe.

I had found the other procedures both difficult of execution and unsatisfactory in results. Plicating the capsule from in front is obviously futile because the lesion is below, in the axillary aspect of the capsule. Axillary operations are most difficult because of the many nerves and blood-vessels

which are encountered and the poor exposure obtained of the joint. Clairmont's operation of using a muscle sling taken from the deltoid is more promising. But the muscle slip is only a weak thing and likely to atrophy. It was actually in a case which had already had Clairmont's operation done and in which it had failed to prevent the dislocation that I first thought of and tried the fascial operation. The patient was a big man and his work that of a "blacksmith's striker." The operation was a complete success and he was able to return to his old work within three months. Since then I have done the

operation many times and I venture to think that in regard both to its simplicity and efficiency it leaves nothing to be desired.

The operation requires three small incisions each about one inch long. The first incision is made just below the coracoid process on the anterior border of the deltoid. (Fig. 2.) By blunt dissection the interval between the deltoid and pectoral muscles is opened and the tip of the finger inserted. Keeping close to the neck of the humerus, it is quite easy to push the finger below the capsule of the joint, until the posterior aspect of the shoulder is reached. Through the tunnel thus made, which passes between the two heads of the biceps muscle and then through the quadrilateral space, a long pressure forceps is passed and made to push the skin outwards behind the posterior border of the deltoid. (Fig. 3.) It is cut down upon by the second posterior incision and a piece of narrow tape pulled through from behind forwards. A second tunnel is then made, again merely by finger-tip pressure upwards under the deltoid muscle from the front incision and, again using a forceps, a passage is completed which ends above the acromion process. The tape is pulled upwards through this front tunnel to emerge above the shoulder. Then a third tunnel is made, joining the posterior with the upper incisions and the tape pulled up through this. The two ends of

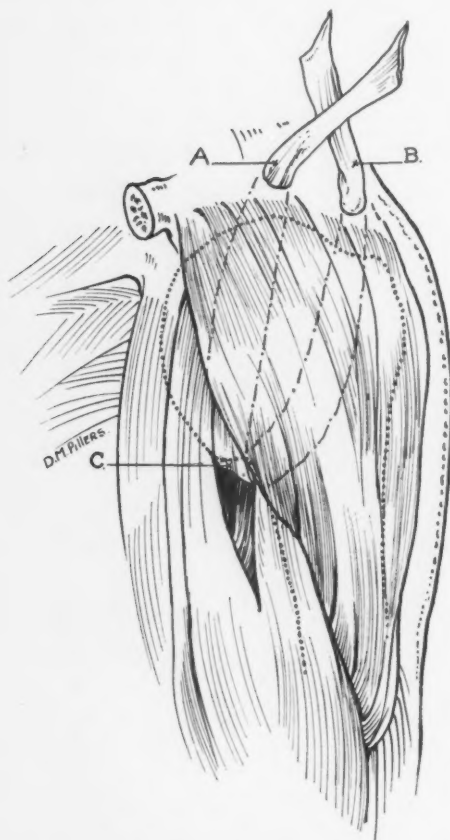


FIG. 2.—Diagrammatic dissection of the shoulder. (A) Point of emergence of fascia in front of acromion. (B) Point of emergence of fascia behind acromion. (C) Site of anterior incision in front of deltoid, showing fascia going through between the two heads of the biceps. (For the sake of clearness the pectoral muscle has been removed.)

the tape are made to cross one another above the acromion with about one inch of overlap. In this way the exact length of fascia required is estimated. This is usually about six to eight inches in length. A strip of fascia lata one inch wide is taken of the same length as the tape and, by means of long forceps, this is made to thread its way round the shoulder-joint. It is pulled as tight as possible and the two ends are firmly sewn together with linen thread or silkworm gut sutures.

## FASCIAL AND TENDON GRAFTS IN FRACTURES

In this way, not only is a strong new sling ligament added to the shoulder-joint, but the actual weak spot in the torn capsule, below, is reinforced by new ligament.

*Elbow. Unreduced Dislocation of the Head of the Radius.*—There is one common association of injuries, *viz.*, fracture of the shaft of the ulna with forward and upward dislocation of the head of the radius, which is always a matter of difficulty and anxiety in treatment.

When the injury is recent, the choice will lie between some type of traction treatment and open operation. The former if efficiently applied should give good line and good union to the ulna and will make subsequent treatment of the radial dislocation much simpler, but it is very unlikely to restore the radial head to correct position and to keep it there. The orbicular ligament has been torn and it is difficult to imagine how any closed reduction can secure its restitution. Therefore, I think that directly the arm has been

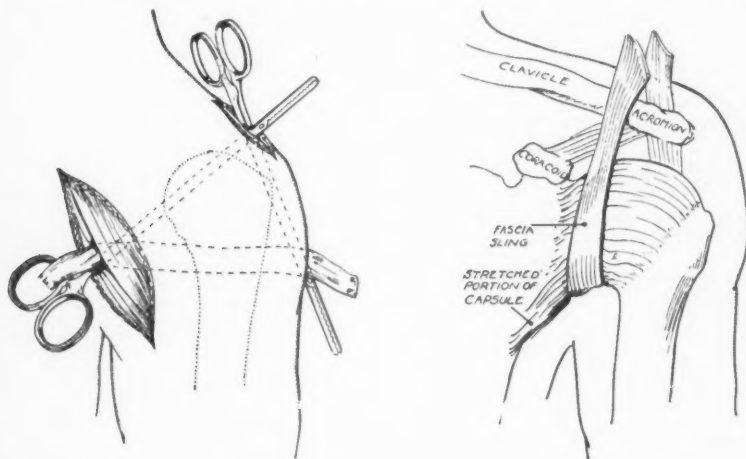


FIG. 3.—Diagram of operation for recurrent dislocation of the shoulder.

restored to full length by manipulation of skeletal traction an open operation should be done on the radius, the torn orbicular ligament restored to place and firmly stitched round the radial head. But unfortunately this early treatment is often slurred or neglected; the arm is placed on an internal angular splint; and it is only some weeks later that it is realized that the radial head is still out of place and in its anterior position seriously interferes with the flexion of the elbow-joint.

When a month or more has elapsed after the accident then it is much more difficult to deal with the radial dislocation. As in the early cases, the first step in treatment must be to restore the ulna to full length and fix it there by some method of osteosynthesis, plate, peg or graft. If there has been difficulty in this part of the operation it is wiser to postpone the radial restitution to a later date; but usually both bones can be dealt with at the same time.

The radial head and neck are exposed by a longitudinal incision about two

inches long. It is comparatively easy to force the radial head back into position, but the crumpled-up, torn orbicular ligament occupies the lesser sigmoid notch of the ulna and a good deal of this torn ligament will have to be cut away before the radius can be made to fit snugly into its socket in the ulna. A free tendon graft is now taken from the palmaris longus if this is well developed, or from the brachioradialis otherwise. This tendon is then threaded round the neck of the radius, using first an aneurism needle, then a stout thread suture to pilot the tendon into the desired place. (Fig. 4.) A hole is drilled in the ulna at the base of the olecranon process, one end of the tendon graft is pulled through this hole, the tendon is pulled as tight as possible and the two overlapping ends sutured firmly by a thread suture. The arm is put up in moderate flexion and encased in a plaster case, which is kept on for six weeks. At the end of this period the case is either cut into two longitudinal halves, or else removed altogether and replaced by a fresh

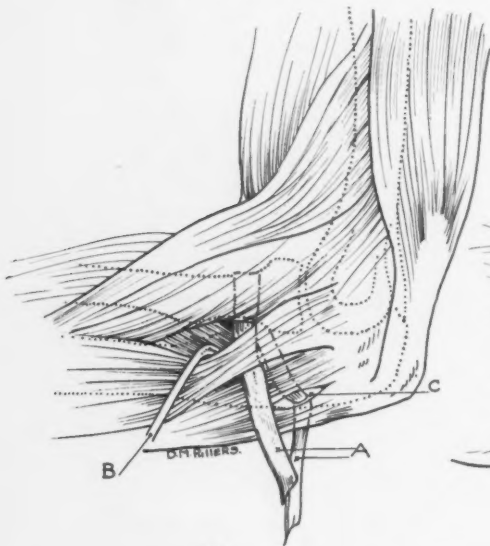


FIG. 4.

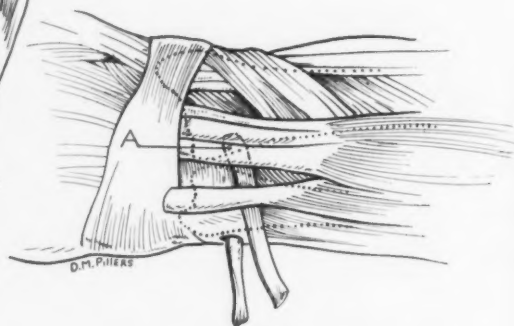


FIG. 5.

FIG. 4.—Diagrammatic section of the elbow, showing the tendinous sling round the neck of the radius. (A) Ends of tendon. (B) Retractor. (C) Hole in the base of the olecranon process of the ulna, through which the tendon is drawn.  
 FIG. 5.—Diagrammatic dissection of the wrist showing tendinous sling round the neck of the ulna. (A) Hole drilled in medial border of radius through which the tendon is drawn.

posterior gutter case from which the arm can be removed once a week for gentle movements—flexion of the elbow; pronation and supination of the forearm. The plaster case will be finally left off at the end of three or four months.

In those cases where the deformity has been allowed to persist for a year or more and where the ulna has become firmly united, then it may be wiser to be content with excising the head of the radius, leaving the ulna untouched.

*The Wrist. Dislocation of the Head of the Ulna.*—This is a comparatively rare injury, and may be complicated by a Colles' fracture. Dealing for the moment only with the ulna dislocation: This is due to rupture of the

## FASCIAL AND TENDON GRAFTS IN FRACTURES

triangular fibro-cartilage which unites the ulna to the radius and this rupture is almost beyond direct repair. Here, again, a new ligament made from a free tendon graft is the best treatment. Three incisions are necessary. First, one in front of the wrist about four inches long. It lies between the tendons of the palmaris longus and the flexor carpi radialis. Through this incision the tendon of the palmaris longus is removed for the graft. By blunt dissection the front of the lower end of the radius is reached and through this bone a hole is made as near its median border as possible. The end of the drill is cut down upon at the back of the wrist and a pilot thread passed through the arm. A third small incision is made over the medial aspect of the neck of the ulna and by means of an aneurism needle passed just in front and then behind the bone, the two ends of the pilot thread are secured and drawn into the ulnar incision. The tendon graft is now pulled round the neck of the ulna by means of the pilot thread, drawn tight and sutured by a linen thread. (Fig. 5.) The arm is put up in plaster extending from the knuckles to a point above the elbow, the hand being dorsiflexed, the wrist in three-quarter supination and the elbow flexed. The plaster is kept on for six weeks.

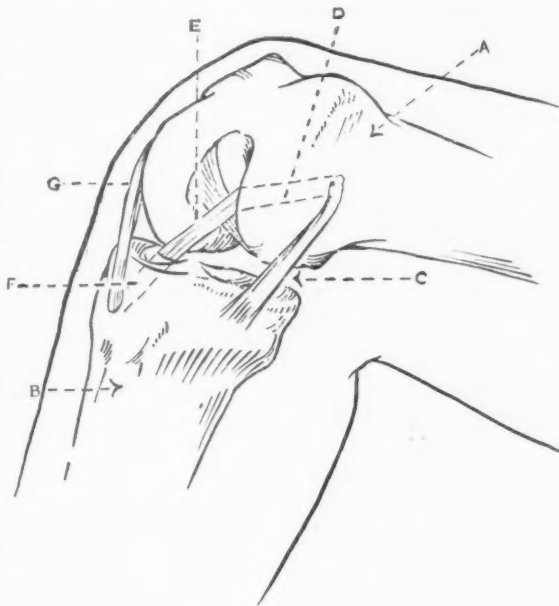


FIG. 6.—Repair of the anterior cruciate ligament. (A) Femur. (B) Tibia. (C) Ilio-tibial band. (D) Tunnel in external condyle of femur. (E) Intra-articular portion, forming new ligament. (F) Tunnel in tibia. (G) Terminal part of fascial band turned up to supplement the internal lateral ligament.

*The Knee. The Crucial Ligaments.*—As I have already said, it was a case of rupture of the anterior cruciate

ligament occurring during the War, in 1916, which first suggested to my mind this idea of utilizing the fascia lata for the repair of the damaged joints. But I have described and discussed this operation elsewhere in some detail so that I refer to it here, briefly, only for the sake of completeness.

The rupture of the crucial ligaments usually results from injuries of great violence, such as produce dislocation of the knee. But the nature of the injury is often overlooked or confused with that of displacement of the semi-lunar cartilages. It is only when the initial pain and swelling have passed off that the characteristic forward or backward displacement of the tibia on the femur in walking or standing is noticed. I believe if the nature of the injury is recognized at once, and if the leg is put up in plaster, natural healing of



the torn ligament will take place. This, in case of complete dislocation of the knee where both crucials are necessarily torn across immobilization in plaster for three months gives a good stable joint. But if this early opportunity of fixation is missed, and the joint once assumes the condition of recurrent subluxation, then we may assume that the ligaments have become permanently damaged, the ends retracted and incapable of reunion. Under these circumstances, unless the patient is always to wear a jointed caliper splint, the only possible remedy is a reconstruction of the torn ligament. Rupture of the anterior ligament, which is much the commonest form of the injury, is manifested by the fact that the tibial head can be pulled forward on the femur, and that this forward displacement is likely to occur in the act

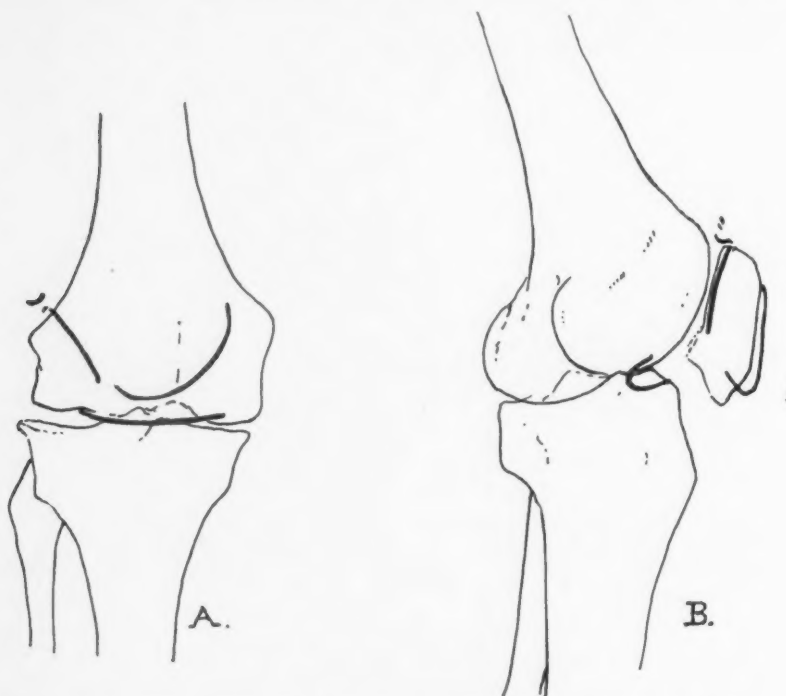


FIG. 7.—Tracing of X-ray of a case where the wire had broken after repair of a fracture of the patella by encircling band of wire. (A) Anterior-posterior view. (B) Lateral view.

of walking when the knee is slightly flexed. There is often some lateral mobility of the knee due to coincident rupture of the internal lateral ligament.

The joint is opened by a J-shaped incision, the long limb of the "J" running up the outer side of the leg and the short curved limb crossing the knee just below the tubercle. In my earlier operations I used to make a free exposure of the inside of the joint by chipping off the tibial tubercle and turning the patella upwards, but I do not think that this is necessary. The joint is opened on the inner side just as in exposure of the semilunar cartilage. Through this incision the torn end of the anterior crucial ligament can be seen. Through the outer part of the incision a strip of fascia lata six inches long is isolated and its upper end is cut, leaving the lower attachment. A hole is then drilled through the outer condyle of the femur with a  $\frac{3}{8}$ -inch twist drill in such a direction as

## FASCIAL AND TENDON GRAFTS IN FRACTURES

to make its point emerge at the intercondylar notch. A second hole is drilled in the inner tuberosity of the tibia so as to emerge just in front of the original crucial ligament. The strip of fascia is then pulled through these two tunnels in the femur and tibia by the use of a probe and pilot tape. It is pulled as tight as possible and fixed to the inner aspect of the head of the tibia by means of an ivory nail, whilst the free end is taken

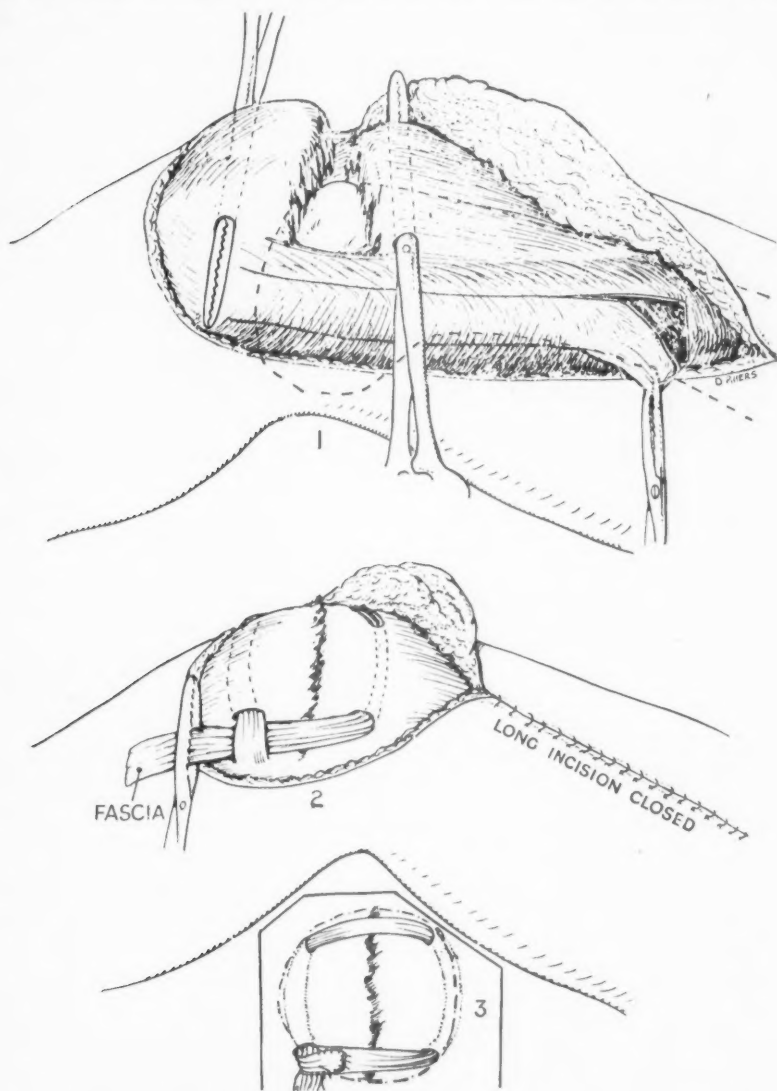


FIG. 8.—Repair of fractured patella by means of an encircling band of fascia lata.

upwards, drawn tight and nailed to the inner condyle of the femur, thus supplementing the internal lateral ligament, which is often lax or weak. (Fig. 6.)

The rupture of the posterior crucial ligament which permits backward displacement of the tibial head on the femur, when the joint is fully extended, must be repaired by use of the semitendinous and gracilis tendons. Two incisions are necessary. The first is a straight incision made on the inner

and posterior aspect of the knee over the line of the hamstring tendons. The gracilis and semitendinous tendons are identified and each is divided about five inches above the knee. The second incision is a short, curved one, over the external and anterior aspect of the joint running up to the outer aspect of the outer femoral condyle. Through this incision the joint is opened and the spine of the tibia is identified. The two holes are then drilled through the inner tuberosity of the tibia and the outer condyle of the femur, each of which converges at the tibial spine. The tendons are piloted through these tunnels, and, having been drawn as tight as possible, their ends are fixed to the outer aspect of the femoral condyle by ivory nails. After each of these operations the leg is put up on a position of slight flexion in plaster-of-Paris for six weeks and then the patient is fitted with a jointed caliper splint which he uses for at least six months.

The result of these operations for the reconstruction of the crucial ligaments have not been uniformly successful. That is to say, the patient is sometimes left with a weak knee which is liable to "let him down." But in recent years the results have greatly improved, which I attribute to a better operative technic and to the more prolonged after-treatment.

*Fracture of the Patella.*—The transverse fractures of the patella with separation of the fragments must be submitted to open operation.

The encirclement of the two fragments by a stout loop of wire is, I think, the operation usually adopted. It gives satisfactory results but it is open to two objections. First, that there is a tendency to osteoarthritis which begins as an overgrowth of bone round the margin of the patella where the wire lies; and second, there is a liability of the wire to break, this distintegration often being quite a late occurrence as in the case depicted. This was a charwoman who had carried on with her work for fifteen years after having the patella wired. Then she came complaining of pain and a pricking sensation in the knee. The X-rays showed that though the knee-cap was soundly united, the wire had broken up into several pieces, one of which lay inside the joint. (Fig. 7.) It was the consideration of these two drawbacks to the wiring operation that led me to devise the following procedure, in which the strong natural suture material, the ilio-tibial band, lies close to hand and can be used instead of any foreign body. The incision is J-shaped, the long limb of the "J" going up the outer side of the leg and the short curved limb going below the patella. The skin is reflected from the knee-cap and the blood clot is swabbed out from the joint. A strip of the ilio-tibial band six inches long is then isolated, divided above and turned down. (Fig. 8.)

A tunnel is made through the quadriceps tendon immediately above the patella, by means of a long pressure forceps and the fascial strip pulled through to the inner side of the knee. A second tunnel is made through the patellar ligament and the fascia brought through it to meet the base of the ilio-tibial band. It is now necessary by means of hook retractors to pull the upper patellar fragment downwards so that it lies absolutely in contact with the lower. Whilst this position is maintained, the fascial band is drawn tight

## FASCIAL AND TENDON GRAFTS IN FRACTURES

and the free end firmly sewn to the base. The torn aponeurosis is accurately sutured over the front and at the sides of the patella and the skin incision closed. No splint is used at the time, but the leg is kept extended between sandbags. At the end of a week the stitches are removed, the leg put in a light plaster case, and the patient gets up and walks with crutches.

It will be noticed by reference to the diagram of this operation, that its rationale is not merely the placing of a fascial strip round the broken kneecap, but the provision for the quadriceps tendon of a new and firm attachment to the outer tuberosity of the tibia, by the natural insertion of the ilio-tibial band. If bony union does not occur or if the fragments cannot be made to come together (as in an old untreated case) then the quadriceps will nevertheless function well in extending the knee-joint because it now has two attachments to the tibia, one through the patellar ligament and the other through the ilio-tibial band.

ANATOMICAL STUDY UPON THE SUPERIOR HYPOGASTRIC  
PLEXUS OR THE PRE-SACRAL NERVE FROM THE  
SURGICAL STANDPOINT

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FROM THE SURGICAL CLINIC OF THE UNIVERSITY OF LWÓW, POLAND, PROFESSOR TADEUSZ OSTROWSKI, DIRECTOR

THE intervention on the so-called pre-sacral nerve was undertaken for the first time by Cotte, in 1924, and has acquired nearly everywhere the right of citizenship.

Although the opinions of some authors about the theoretical basis of this intervention vary greatly, yet there is no doubt that the so-called pre-sacral nerve plays an important part in the dysfunction of the pelvic viscera. Jaboulay had already, in 1898, expressed the hypothesis that some pelvic neuralgias of women are dependent on functional troubles of the sympathetic system and had called the pelvic sympathetic the true pelvic brain.

After a period of groping in the dark both from the anatomical, physiological and pathological point of view, thanks to researches and works carried out in the last ten years, a more fundamental basis has been created especially for the anatomical distribution of the sympathetic and parasympathetic innervation of the pelvic viscera. This has facilitated the defining of indications for several types of operations at present more or less common, more or less successful and more or less eclectic in regard to some fragments of the pelvic sympathetic. All operative attempts on the pelvic sympathetic are based on the visceral sensibility and on viscerosensitive reflexes, *i.e.*, on the mechanism producing pain and on the lines of pain sensibility. The wide area in which we employ at present the resection of the pre-sacral nerve or, more strictly, of the superior hypogastric plexus, necessitates on our part not only a more exact anatomical knowledge of this subject but, before all, a thorough investigation of the subject from the point of view of the operation. It is well known that there are many anatomical domains which did not awaken any special interest of anatomists and that only owing to the needs of the clinic and the surgeon more exact researches were undertaken, that is to say they were only undertaken, because they seemed necessary to the clinic and the surgeon. We do not share the opinion of some authors that, if there is any particular indication for the intervention on the superior hypogastric plexus, it suffices to resect the fibrous retroperitoneal blade where are situated the sympathetic nerve fibres. This means merely following the line of least resistance. If one does not see what one resects, one can never tell whether



# ANATOMICAL STUDY OF SUPERIOR HYPOGASTRIC PLEXUS

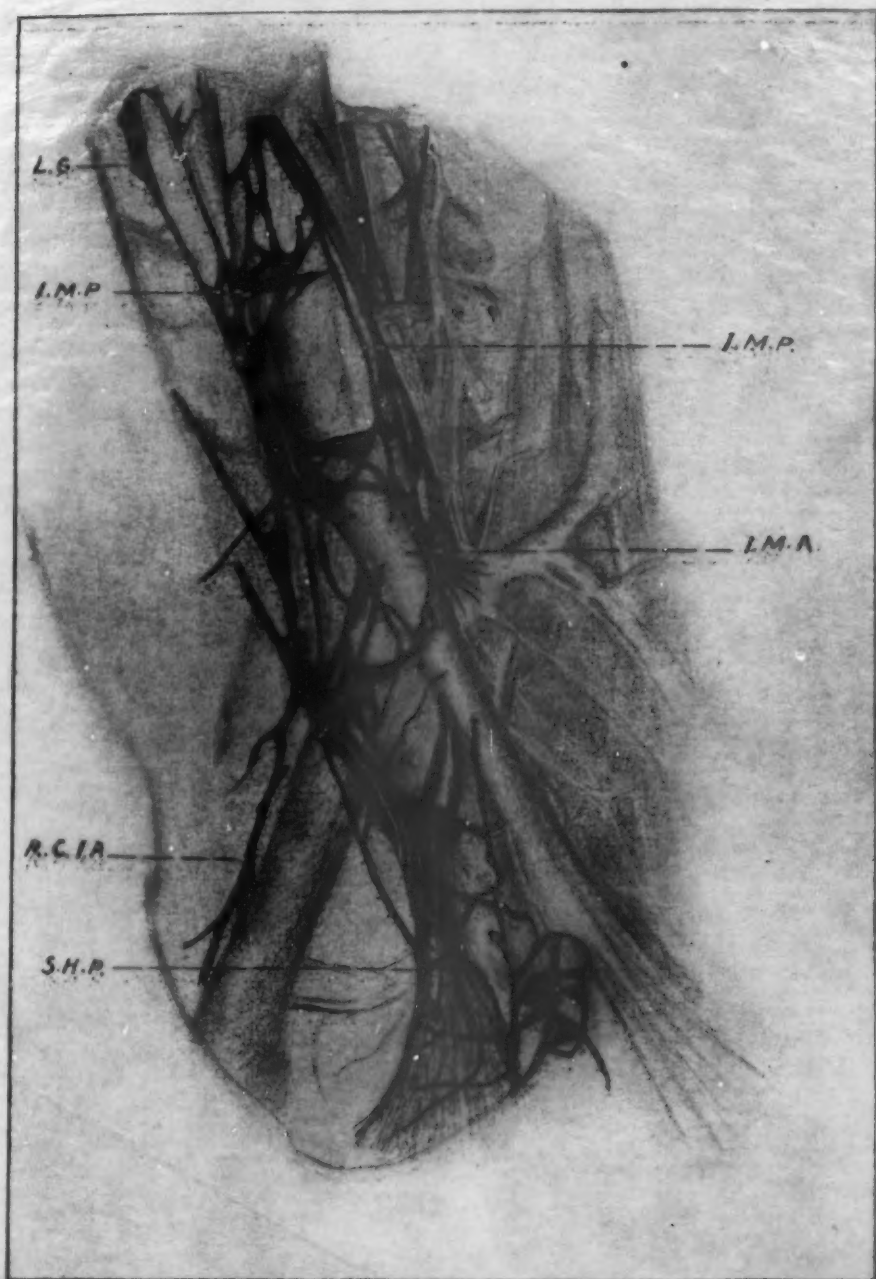






FIG. 1.—The superior hypogastric plexus forms a solid flattened blade, easily separable. L.G.—Lumbar ganglion. I.M.P.—Inter-mesenteric plexus. I.M.A.—Inferior mesenteric artery. R.C.I.A.—Right common iliac artery. S.H.P.—Superior hypogastric plexus.



## ANATOMICAL STUDY OF SUPERIOR HYPOGASTRIC PLEXUS



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the failure of the intervention is due to wrong indication or to wrong technic. The result, whether favorable or not, will always be uncertain and it will always lack a solid basis from which conclusions may be drawn. More extended resections of the pelvic and lumbar sympathetic reaching up to the inferior mesenteric ganglion or the renal plexus, able to influence the pain that has its origin in the internal spermatic plexus, requires the same anatomical accuracy.

If we effect the cure of the pain or of the functional disturbances by laparotomy, we should then have a sure indication that we are affecting the total hypogastric plexus, so we must execute its most accurate surgical removal.

The surgery of the sympathetic is, it is true, very delicate and it remains so throughout the course of the sympathetic system beginning with ganglions to its connecting rami (r. communicantes) and their terminal fibres.

Although the physiology, pathology and therapy of this system show many deficiencies which are not likely to be overcome for some time to come, the anatomy is in a better position, as it can—more or less justly—be spared this objection.

What surprises the surgery of the sympathetic can afford to the operator is shown best by the case of Aubert as reported by Leriche. Aubert removed, as he thought, the stellar ganglion in the angina pectoris, and the autopsy showed that the stellar ganglion remained intact.

Cotte, in his monography on the pelvic sympathetic, mentioned a case of the recurrence of the dysmenorrhœa where the second intervention showed the fibroneurome of the pre-sacral nerve which was cut according to all operative and microscopical findings only partially. These are the published cases, but it is well known that the publications of this kind are not frequent.

To complete our introduction from the clinical point of view we must state that the resection of the pre-sacral nerve was executed in the dysmenorrhœa and the vaginismus, in the pelvic neuralgias called essential, in cystalgias, the rebel leucorrhœa and hydrorrhœa, in disturbances of genital sensibility, in the pruritus vulvaris and perinealis, in the ovaritis sclero-cystica, and in the pelvic pains connected with the inoperable cancer of the uterus prostata and the urinary bladder.

What is the real importance of the resection of the pre-sacral nerve in all these lesions and what is its future and its late results, it is difficult for us to say now.

All that we can actually say at present is that satisfactory results have been published by many authors.

Taking into account the results published, one has the impression that the resection of the pre-sacral nerve ought to find a wide application which from the social point of view would be of great importance.

It is well known that pain results from almost every chronic lesion of the genital organs of the woman.

As long as one was unable to associate the pelvic pain with the sympa-

# ANATOMICAL STUDY OF SUPERIOR HYPOGASTRIC PLEXUS

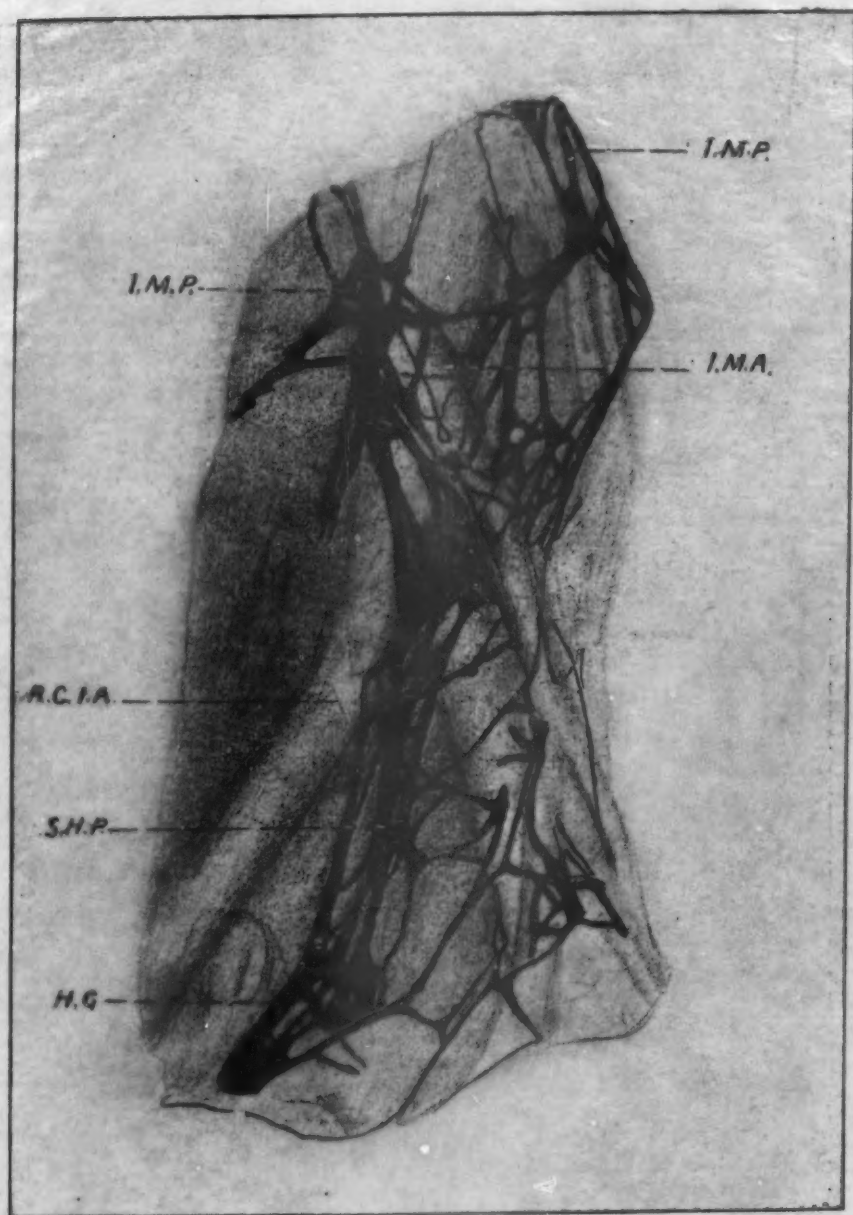






FIG. 2.—The superior hypogastric plexus slightly developed in the form of network of wide meshes. The hypogastric ganglion appears as a big, solid body. The inter-mesenteric plexus is seen here very clearly. I.M.P.—Inter-mesenteric plexus. I.M.A.—Inferior mesenteric artery. R.C.I.A.—Right common iliac artery. S.H.P.—Superior hypogastric plexus. H. G.—Hypogastric ganglion.





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thetic system, the treatment resorted to for inhibiting the pain consisted in one intervention which practically consisted in a more or less extensive castration of the woman.

Actually through the surgical suppression of the pain which does not impair the physiological functioning of the genital apparatus and which indeed brings about an improvement, it should be possible to save a great number of women from so grave mutilation as the castration.

And now let us consider the question of the technic of the intervention, section or resection? There are authors who advise to perform a simple section across the neurofibrous retroperitoneal blade at the level of the fifth lumbar vertebra. This should be sufficient for interruption of all sensory tracks originating in the superior hypogastric plexus. We do not share this opinion, although we do not know at present the laws that govern the sympathetic regeneration.

The resection of the plexus has almost completely eliminated the periaarterial sympathectomy on the abdominal aorta, on the iliac and uterine arteries which was so far performed for the same or analogous lesions. According to our opinion the resection of the superior hypogastric plexus is a more easy intervention than the sympathectomy from the technical point of view, its result is more sure and involves no complications.

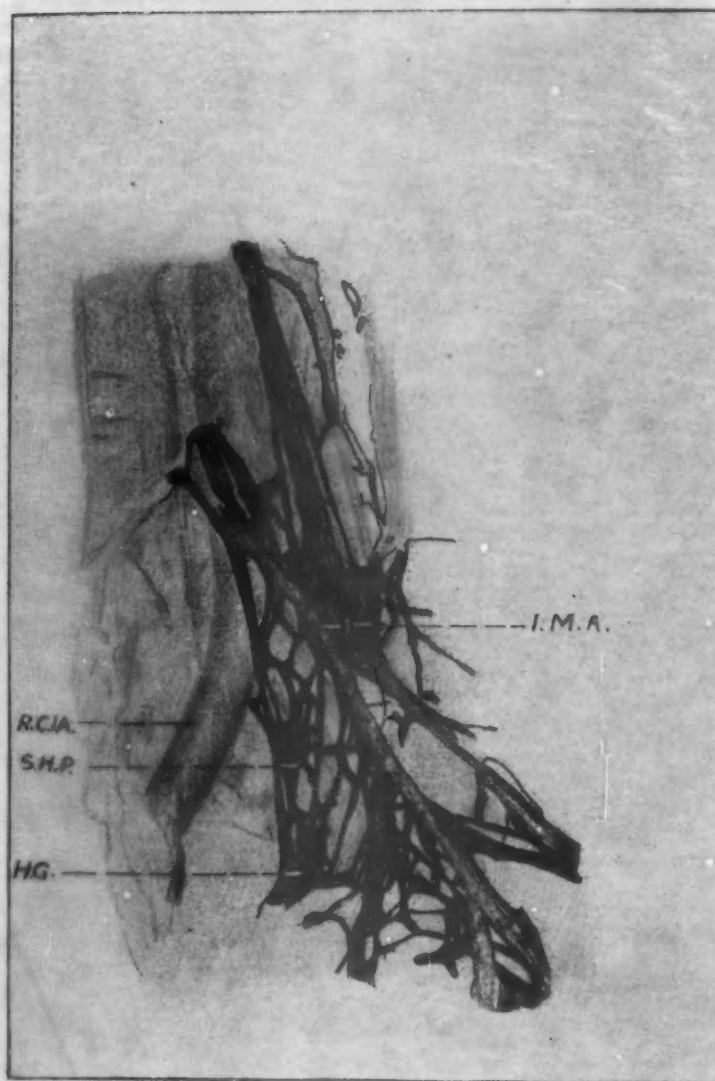
Now the question of nomenclature. There are two names for the same segment of the pelvic sympathetic. An older one, as it were, traditional, the most frequently employed one, so far, in the literature upon this subject, but which does not correspond with the anatomical truth and with the real state of matter. It is the name given in 1913 by Latarjet and Bonnet: pre-sacral nerve (*nerf présacré*). This name has, in our opinion, merely a topographical significance which is not conformable to the macroscopical structure of the fibres and ganglia accumulated in a confusion on the anterior face of the sacral bone.

The name given for the segment in question of the pelvic sympathetic by the eminent French anatomist Hovelacque, *viz.*, superior or hypogastric plexus comprises in its definition all that we find during the dissection. This is why, in order to make ourselves better understood, we shall use from now on the nomenclature given by Hovelacque in 1927.

We have performed our anatomical researches on thirteen cadavera. To provide evidence of these researches we present here photographs, so to speak, typical of these cases, together with respective schemes.

The intervention is commenced by medial low laparotomy. After opening the abdominal cavity the sigmoid colon is pushed to the left, and the small intestine upwards and rightwards. The radix mesenterii is exposed. According to its course the superior hypogastric plexus can be isolated on a larger or smaller area. Just after the sigmoid colon has been pushed aside, in some cases we can observe the course of the plexus which is seen through the posterior peritoneal layer. In other cases we can follow its course by palpation only, as we can feel the hard cord or the flattened blade which gives a special and distinct sensation to the finger tips. There are, however, cases where only a very accurate dissection permits us to differentiate the fibres of the plexus. All these eventualities depend on the formation and the anatomical structure of the superior hypo-

ANATOMICAL STUDY OF SUPERIOR HYPOGASTRIC PLEXUS





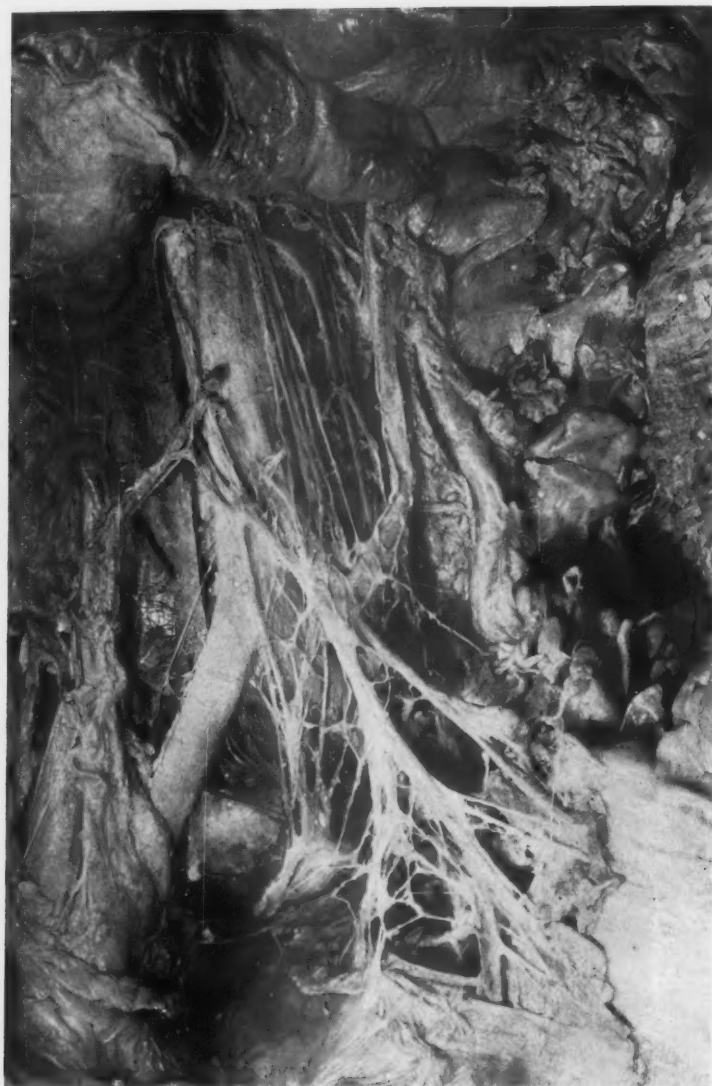


FIG. 3.—The superior hypogastric plexus and the inferior mesenteric plexus extraordinarily developed provide very numerous anastomoses. I.M.A.—Inferior mesenteric artery. R.C.I.A.—Right common iliac artery. S.H.P.—Superior hypogastric plexus. H.G.—Hypogastric ganglion.





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gastric plexus, on its more or less deep position in relation to the peritoneum posterior, on the manner of insertion of radix mesenterii, on the anatomical disposition of the sigmoid and the hæmorrhoidal arteries which, situated more medially, can completely cover the plexus.

It is quite evident that the abundance of the retroperitoneal areolar tissue and the chronic inflammatory processes obscure the clearness of the anatomical disposition and render the precise recognition difficult. In two of our cases in enteroptosis the lower course of the third portion of the duodenum reaching as far as the bifurcation of the abdominal aorta presents us some difficulties.

In cases of the superposition of the plexus by sigmoid and superior hæmorrhoidal arteries, these must be pushed to the left in order to obtain access to the plexus.

The superior hypogastric plexus from the point of view of its global anatomical structure presents itself either as a simple flattened or gangliated cord, or in form of a fan-like or fenestrated blade in its superior part, or in form of small, fine fibres which unite themselves into a network. (Figs. 1, 2, 3 and 4.) Almost in all cases we find in the plexus a limited number of small ganglions (2 to 4). Let us say that the sympathetic is—not so much in its course—but rather in its anatomical formation and structure—subject to considerable variations, and therefore one very seldom finds two identical plexuses. It occurs more often that we find two analogous plexuses resembling one of the above-described types.

The main trunk of the plexus is always shifted to the left, and its principal mass rests on the left common iliac artery. The trunk itself is formed by fibres distinctly visible and separable, which, however, constitutes a plexiform entity, well bounded anatomically, which lies on the body of the fifth lumbar vertebra.

The length of the plexus is comparatively constant and measures 6–8 cm. (2.36–2.54 in.); its width varies according to its anatomical structure.

The fenestrated or plexiform types are wider; the trunk-like forms narrower and easier to dissect.

Inasmuch as the superior hypogastric can be considered as a one-layer formation, the sympathetic elements which give origin to the plexus are a multi layer formation which runs amidst the vasa iliaca and the lymphatic glands that are so numerous in this region. Generally speaking, the superior hypogastric plexus is formed in its principal mass by branches of the inter-mesenteric plexus, stronger and better developed on the right side.

The relation of the plexus to the sympathetic lumbar trunk or to its last ganglia is that the filaments, more or less delicate, having their origin in the ganglia, pass behind covered by a coat of the areolar tissue, condensed and thick, so that it is easy to isolate the common iliac arteries. (Fig. 4.)

The middle sacral artery is crossed by the right fragment of the plexus. It is the plexus without reaching either the middle artery or the vein.

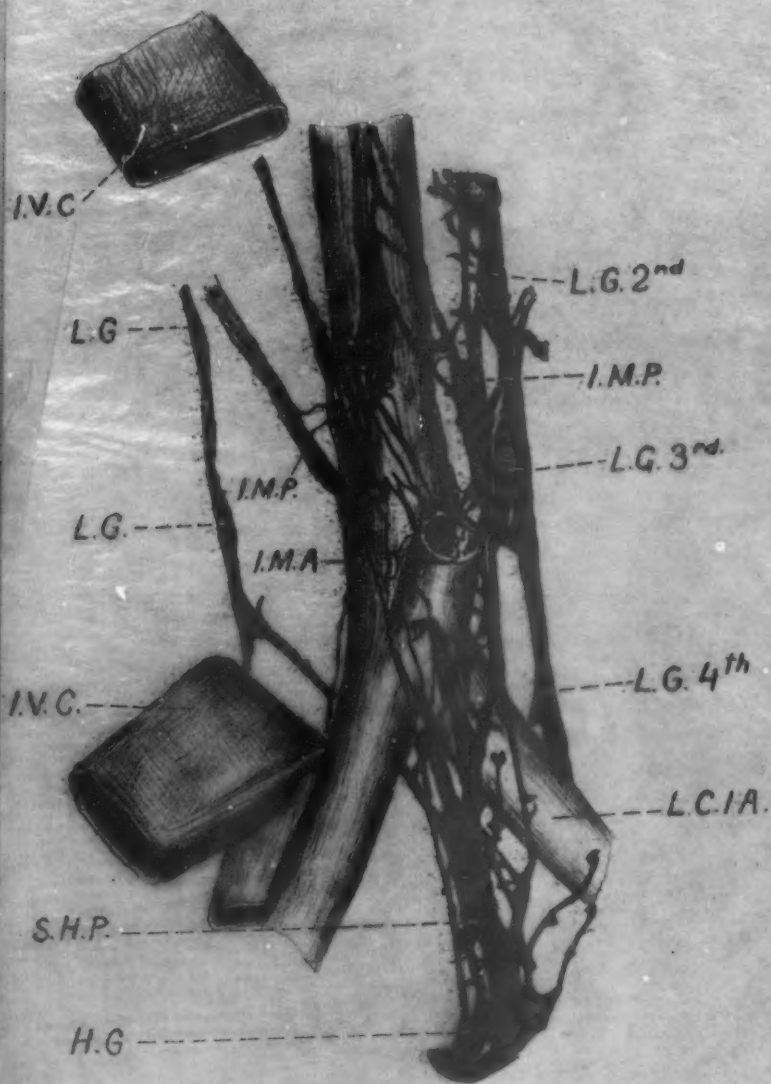
The superior hypogastric plexus ends with the hypogastric nerves in the hypogastric ganglia.

The nerves and ganglia taken together constitute the inferior hypogastric plexus.

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FIG. 4.—The superior hypogastric plexus appears in the form of delicate fibres running parallel. The inferior mesenteric artery with its sympathetic plexus is removed. The inferior vena cava is also cut and retracted downwards in order to expose the sympathetic chain with its ganglions on both sides and to show its relation to the superior hypogastric plexus. (The lumbar sympathetic chain on pincers.) I.V.C.—Inferior vena cava. L.G.—Lumbar ganglion. I.M.P.—Inter-mesenteric plexus. I.M.A.—Inferior mesenteric artery. L.C.I.A.—Left common iliac artery. S.H.P.—Superior hypogastric plexus. H.G.—Hypogastric ganglion.



# ANATOMICAL STUDY OF SUPERIOR HYPOGASTRIC PLEXUS

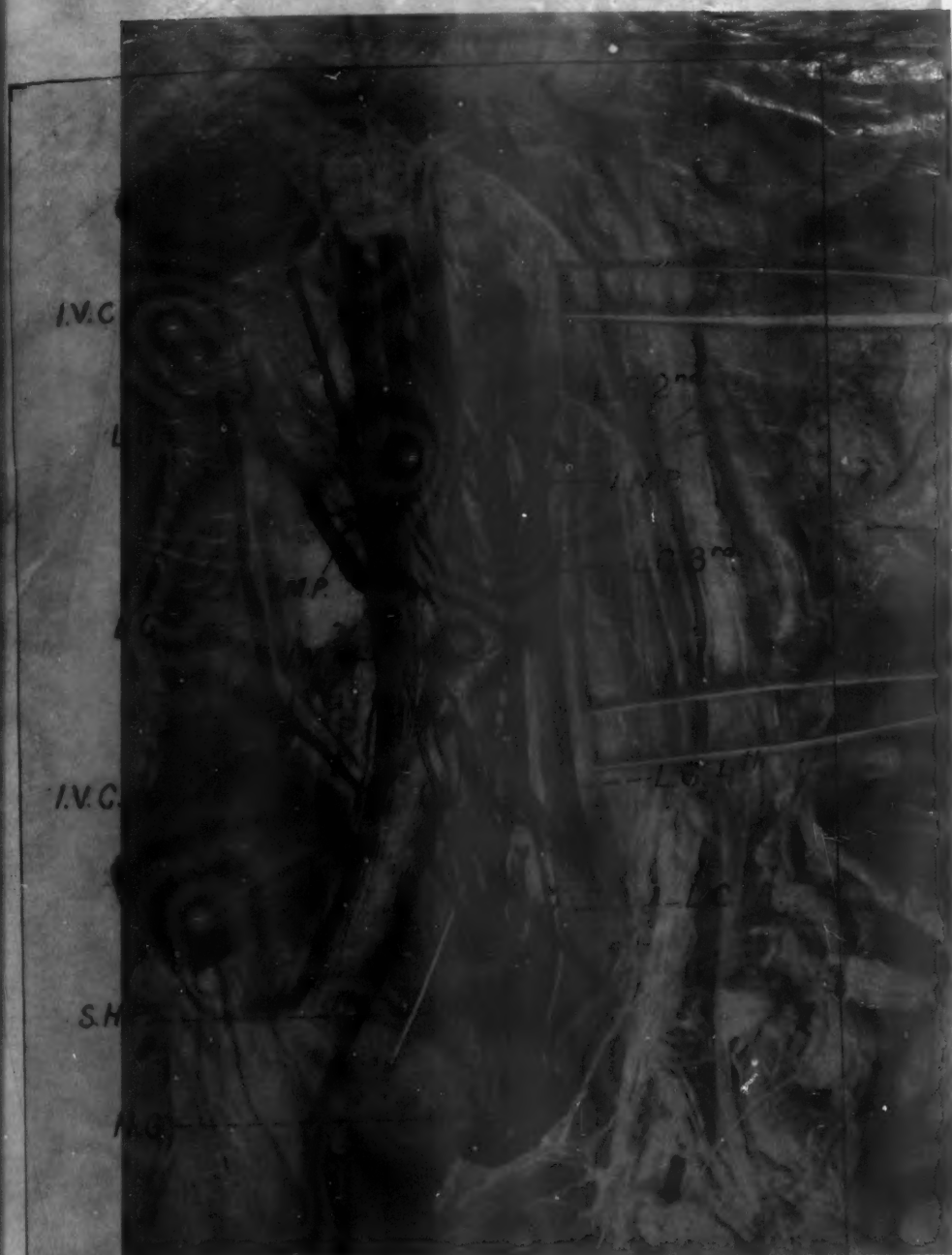


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- <sup>6</sup> Latarjet and Bonnet: Le plexus hypogastrique chez l'homme. Lyon chirurgical, vol. 9, No. 6, 1913.
- <sup>7</sup> Latarjet and Rochet: Le plexus hypogastrique chez la femme. Gynécol. et Obstétr., 1922.
- <sup>8</sup> Learmonth and Braasch: Resection of the Presacral Nerve in the Treatment of Cord Bladder. Surg., Gynec., and Obst., vol. 51, p. 494, 1930.
- <sup>9</sup> Leriche and Stricker: Recherches expérimentales sur le nerf présacré. Bull. et Mém. de la Soc. Nat. de Chirurgie, séance du 1er juin, p. 819, 1927.

## THE PROBLEM OF EXTRADURAL HÆMORRHAGE

A REPORT OF 14 CASES

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NOT many years ago extradural hæmorrhage due to injury of the middle meningeal artery was regarded as a relatively rare occurrence, but nowadays, owing to the great increase in road accidents, the condition undoubtedly calls for treatment much more frequently. Should the condition be suspected it is very often difficult to make a positive diagnosis, as the symptoms are so often obscured by some co-existent cerebral lesion or complication. There is a progressive increase, year by year, in the number of head injuries, a large proportion of which occur in children. However, cases of extradural hæmorrhage are uncommon in children and two cases only have occurred in a series of 100 cases of head injuries at the Belgrave Hospital for Children during the years 1920-1930. Both these cases are included in our series.

In children the membrane bones of the vault of the skull are very elastic, and for this reason trauma more often results in a bending rather than a breaking of the bone. Further, the sutures of the skull are occupied by a considerable amount of cartilaginous or fibrous tissue, both of which serve as buffers, and thus tend to diminish the effects of trauma. The dura mater is more closely adherent to the skull bones in children than it is in adults, with the result that any extradural hæmorrhage which may occur is less extensive in the former than in the latter. In children the skull bones contain very little diploë, and this anatomical fact prevents any difference in the extents to which inner and outer tables of the skull are fractured. If one table is fractured in a child the other must necessarily be involved as well. The brain of a child is more tolerant of a traumatic lesion, and is thereby much less liable to permanent injury than is that of an adult. Although three stages are described in a classical case of extradural hæmorrhage, yet these are rarely seen today. The first stage is that of a primary concussion, and is due to the blow. The second stage, consisting as it does of a temporary return of consciousness, the so-called "lucid interval," often does not occur at all or if it does is of such short duration as to be often overlooked. The third stage is one of cerebral compression causing a gradual supervention of coma, generally within twenty-four hours, and that usually without any considerable rise in temperature. In some cases of extradural hæmorrhage associated with fracture of the skull, the patient may survive for an hour or so



only, while in others a week or even ten days may elapse before the patient, in spite of receiving no relief, dies by operation.

We are convinced that many cases of extradural hæmorrhage are missed because surgeons are on the lookout for classical cases with all the orthodox signs and symptoms, and it is on this account that we now record a series of cases which have come under our own observation since 1915. Frequently accessory signs are of more definite value in diagnosis than the orthodox symptoms, and of these the occurrence of twitchings of the head or limbs, dysphasia or aphasia, facial palsy or hemiparesis are indicative of the need

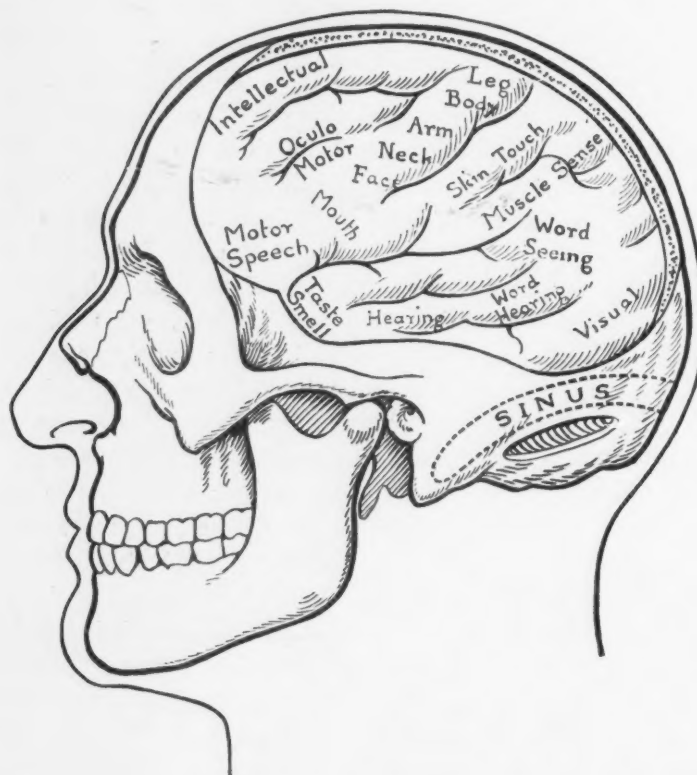


FIG. 1.—Diagram showing relation of convolutions of the brain to the exterior of the skull. The relation of the motor area is indicated.

for immediate operation. (Fig. 1.) The pupils sometimes give very valuable information, but at times may lead a keen observer astray. The pupil on the injured side will often be contracted at first, owing to the irritation of the third nerve. As the intracranial pressure rises, the third nerve becomes paralyzed and dilatation of the pupil takes place owing to the unopposed influence of the cervical sympathetic. Should the pressure persist, its effect is transmitted across the mid-line, with the result that the third nerve on the other side is irritated, and contraction of the opposite pupil ensues. This in turn will be followed by dilatation of the pupil as the third nerve becomes paralyzed. If operation is not performed to relieve the condition, death

## PROBLEM OF EXTRADURAL HÆMORRHAGE

results, both pupils being dilated and fixed, owing to the fact that both third nerves are paralyzed. (Fig. 2.) However, too great an importance must not be attached to the pupils, as they often exhibit abnormality.

The post-mortem records of every large hospital demonstrate the fact that cases of undiagnosed middle meningeal hæmorrhages still occur. The post-mortem records of King's College Hospital from 1920-1930 reveal the fact that three cases of extradural hæmorrhage were first discovered by the pathologist. Although this is not a large figure, if all the hospital records of the country are pooled the number of unrelieved fatal cases each year must be considerable.

In all probability cases of subdural hæmorrhage are more frequent than those of extradural origin, and as a rule the latent period in the former is longer. In all cases of suspected middle meningeal hæmorrhage, whether the operation reveals an extradural hæmorrhage or not it is advisable to incise the dura mater in order to discover a possible subdural hæmorrhage, which if found can then be dealt with.

CASE I.—George H., aged seventeen, was knocked down by a motor bicycle on a

foggy night, November 14, 1915. He hit his head on the curb and did not appear to be seriously injured for the first half hour after the accident. Subsequently, however, he gradually became dazed and drowsy and was brought to hospital about an hour after the accident. On admission the patient was not unconscious but was very drowsy. There was a large hæmatoma on the left side of the head just above the zygoma. There was no actual scalp wound. The pulse was 70 and the blood-pressure 110/70. Both pupils were small but reacted to light and accommodation. The patient was admitted to the Observation Ward at 6.30 P.M. At 8 P.M. he became restless. Lumbar puncture was performed and blood-stained cerebrospinal fluid was withdrawn. Soon after this the patient became aphasic and twitchings of the right hand were observed. The pulse had now fallen to 60. Respirations 16. Middle meningeal hæmorrhage on the left side was diagnosed and it was decided to operate. (Fig. 3.)



FIG. 2.—Drawing of specimen in the Royal College of Surgeons of England showing middle meningeal hæmorrhage causing compression of the brain.

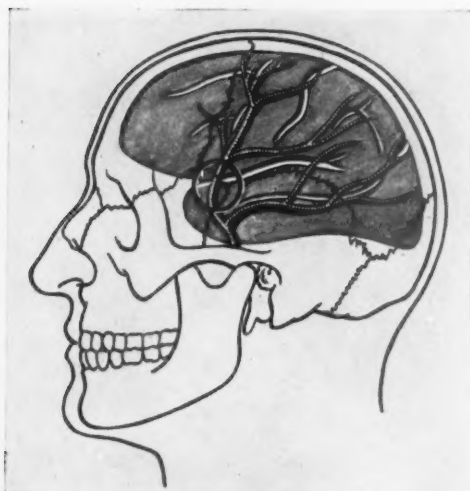


FIG. 3.—Diagram showing relation of trephine hole to the middle meningeal artery and the relation of the latter to the convolutions and surface of the brain.

## WAKELEY AND LYLE

A left intermusculotemporal decompression was performed under ether anæsthesia. A small extradural clot was removed and the middle meningeal artery tied on the dura mater. The dura mater was opened and an œdematous brain exposed. (Fig. 4.) The wound was closed without drainage. Patient made an uninterrupted recovery and left hospital sixteen days after the operation. He joined the army in July, 1917, and was killed in France in December, 1917, just over two years after his accident.

CASE II.—William B., aged twenty-six, an able seaman, was admitted to the R. N. Hospital, South Queensferry, June 16, 1916, in an unconscious condition. The history of his accident was as follows:

While running round the deck he tripped and fell and hit his head on an iron stanchion. He was concussed and was taken to the sick bay where he vomited copiously. The accident occurred at 8.30 A.M. and by 10 A.M. he became unconscious. He was taken ashore and admitted to hospital at 1 P.M. Lumbar puncture was performed and blood-stained cerebrospinal fluid under considerable pressure was withdrawn. There was a contusion just behind the right external angular process but otherwise there were

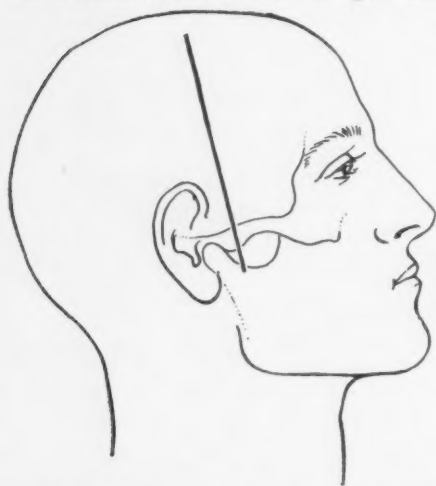


FIG. 4.—Diagram showing a useful vertical incision which allows the operator adequate room in performing an inter-musculotemporal decompression.

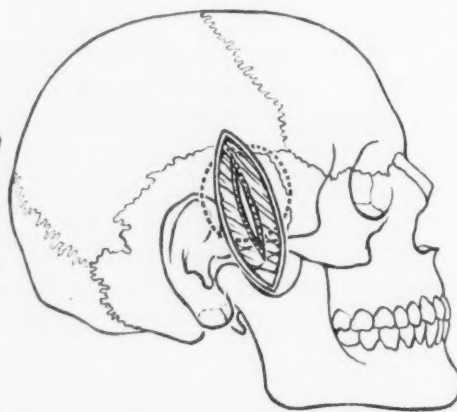


FIG. 5.—Diagram showing how exposure of the skull can be obtained through a vertical incision.

no clinical signs whatsoever. At 3 P.M. the same day a subtemporal decompression was performed and a large extradural blood-clot was removed. The dura mater was not opened and the wound was closed without drainage. The patient stood the operation well but did not recover consciousness and died twelve hours later.

At the autopsy there was no fresh extradural hæmorrhage found, but the underlying brain was œdematous, and the convolutions were flattened.

In this case the patient would probably have recovered if the dura mater had been opened at the time of the operation.

CASE III.—John H., aged thirty-two, a leading seaman, was admitted to H. M. H. S. "Garth Castle" at Scapa Flow, April 19, 1918, in an unconscious condition. Three hours previously he had fallen ten feet, head first, into a picket boat. He was stunned by the impact but after a few minutes was quite conscious and was lifted aboard his ship. However, after a rest of just over an hour in the sick bay he complained of headache and vomited. He then became unconscious and remained in the same state until he was admitted to the hospital ship. On examination there were definite subconjunctival hæmorrhages in both eyes and a right facial paralysis. The patient could just be roused at times when the facial paralysis became very obvious. There was also definite weakness of the right arm. While the operating theatre was being prepared the patient

## PROBLEM OF EXTRADURAL HÆMORRHAGE

became comatose and the pulse rate was 52. A right subtemporal decompression was performed without an anæsthetic. A considerable extradural clot was exposed and the middle meningeal artery was underrun with a silk suture. The dura mater was opened and a considerable amount of blood-stained cerebrospinal fluid escaped. The brain was very bruised. The wound was closed and a gauze drain was inserted down to the dura mater. The patient never recovered consciousness and died twelve and a half hours after admission to the hospital ship.

At the autopsy a considerable extradural and intradural hæmorrhage was found on the left side.

CASE IV.—George A., aged twenty-three, a deck hand, was admitted to H. M. H. S. "Garth Castle" at Scapa Flow, March 12, 1919, after having received a blow on the head from the traveling tackle of a crane. He was knocked down by the impact and rendered unconscious. When he arrived on board the hospital ship some four hours after the injury he was just conscious and was found to have a large lacerated wound in the right temporal region. His pulse was strong but only 58 to the minute. He was put to bed and watched. About half an hour after admission he had a fit which started in his left hand and then became generalized. After this his left arm became paralyzed. Operation was decided upon and under gas and ether anæsthesia the wound in the right temple was explored. There was a small depressed fracture just above the mid-point of the zygoma, and blood was oozing out around this. A small trephine hole was made to the side of the fracture and the depressed portion of bone elevated and removed. With the aid of nibbling forceps the opening in the bone was enlarged. A considerable extradural clot was seen and removed; the dura mater was opened but no intradural hæmorrhage was seen. The wound was closed without drainage. The patient was very irritable for four days after the operation, otherwise he made an uneventful recovery. He recovered completely from the paralysis of the left arm. (Fig. 5.)

CASE V.—Charles H., aged fifteen, was admitted to hospital April 24, 1923, having been knocked down by a motor-cyclist. On admission, which was an hour after the accident, the patient was concussed and somewhat irritable. There was a large bruise over the right temporal region, but otherwise nothing else was discovered. The boy was put to bed and passed a comfortable night. He ate some breakfast next day, but vomited the whole meal an hour later when he said he felt sleepy and had a headache. About an hour after this, about seventeen hours after his accident, he was found to be unconscious with a pulse rate of 60. The right pupil was widely dilated, did not react to light, while the left one was quite small and reacted well to light.

A right-sided subtemporal decompression was performed without an anæsthetic and a large extradural clot removed. The middle meningeal artery was not completely severed, but a large rent was seen in the vessel. Ligation was performed on either side of the hole. The wound was closed without drainage. Recovery was uneventful and the patient left hospital sixteen days after the operation.

This is the only case in our series in which a distinct rent in the middle meningeal artery was found.

CASE VI.—Charles H., aged forty, was admitted to hospital May 29, 1923, having been knocked down by a tram. On admission, just under an hour after the accident, the patient was unconscious and was bleeding from the nose. The left pupil was dilated. A deep scalp wound, two inches long, was seen in the left parietal region. The patient gradually became worse; respirations slowed down to 12 and the pulse rate to 40. Two hours after admission the scalp wound was excised and a fracture was seen running across the left frontal and parietal bones with many radiating fissures. A large decompression was performed and under the bone an extensive extradural clot was discovered and removed. The patient made a slow but complete recovery and left hospital six weeks after his admission. In this case if operation had been postponed for even an hour or so, a fatal result would undoubtedly have taken place.

## WAKELEY AND LYLE

CASE VII.—Barbara W., aged six, was admitted to the Belgrave Hospital for Children March 3, 1925, after having been knocked down by a motor-car. She was unconscious on admission to hospital which was about half an hour after the accident. There was a hæmatoma over the right parietal region where she had been hit by the car. The pulse rate was 100 and the temperature 98°. The patient was put to bed and an hourly pulse chart was kept. Four hours after admission the patient became restless and the pulse rate was 120. The patient vomited twice. Six hours after admission the pulse rate was reduced to 60 and the patient became drowsy and the nurse reported twitching of the face. Decompression was decided upon and was performed under local anæsthesia. A vertical incision was made just above the pinna, the temporal muscle was split in the direction of its fibres and the skull was opened by means of a burr. A large extradural clot was exposed and removed. The middle meningeal artery was found completely severed and was secured. The patient's pulse rate rose to 110 and she started to cry as the stitches were inserted in her scalp. Recovery was uneventful and there were no complications, the little patient leaving hospital after fifteen days.

This patient was examined again in December, 1933, nearly nine years after the accident, and clinically no hole whatever was discoverable in the skull. This case shows how well the skull bones will close in children.

CASE VIII.—John H., aged one year and two months, was admitted to hospital July 7, 1928, having fallen from a first-story window on to the pavement, a distance of some eighteen feet. On admission to the Belgrave Hospital for Children the child was crying lustily and a large soft hæmatoma could be seen and felt over the left parietal region. The child was put to bed and given a bottle in an attempt to comfort it. The baby took the bottle well, but vomited the whole feed about an hour later. After this the child became restless and cried continuously. The pulse rate varied a great deal, and about ten hours after admission the patient was unconscious with a pulse rate of 66 and slow respirations. The infant was taken to the operating theatre and a subtemporal decompression was performed on the left side; no anæsthetic was used. A huge extradural clot was exposed and removed. No definite bleeding vessel was seen in this case. The wound was closed, a small corrugated rubber drain having been inserted. Before the last scalp sutures were inserted the baby was crying lustily.

In this case, if operation had not been carried out promptly the clot would have been discovered at autopsy instead of at operation.

The baby made a complete recovery with no aftermath whatever.

This infant was seen a year later in 1929, and no abnormal neurological signs could be discovered.

CASE IX.—Joseph H., aged twenty-one, was kicked on the right side of the head by a horse on February 10, 1928, and was admitted to hospital two hours after the accident in an unconscious state. On examination a large hæmatoma involving the right temporo-parietal region with no laceration of the scalp was found. The patient was put to bed and after an interval of some fifty minutes he gradually recovered consciousness, when it was found that his left arm was paralyzed. The pulse rate, which was 80 per minute on admission, dropped to 60 per minute and the right pupil became dilated.

A subtemporal decompression was performed on the right side, two hours after admission to hospital, through a long vertical incision just in front of the pinna. A hæmatoma was found under the scalp due to laceration of the superficial temporal artery. The temporal muscle appeared to be pulped and a depressed fracture of the squama of the temporal bone was exposed. On elevating the depressed fragments of bone a large extradural clot was found and removed. The dura mater was carefully examined but no laceration was discovered. The middle meningeal artery was found to be severed about half an inch from the foramen spinosum. As ligature of this vessel was proved to be a matter of some difficulty, the foramen in the bone was plugged with a small piece of match stick. A small incision was made in the dura mater to inspect the brain; no



## PROBLEM OF EXTRADURAL HÆMORRHAGE

bleeding was discovered. The wound was then closed and a small drain inserted through the scalp for twenty-four hours. The patient made an uninterrupted recovery and was discharged eighteen days after the operation. When seen two years later he was doing full work as a printer's assistant, and had no signs or symptoms referable to his accident.

CASE X.—Frederick W. J., aged seventy-one, was admitted to hospital, October 25, 1930, having been knocked down by a motor-car. On examination he appeared dazed and complained of pain over the left temporo-frontal region. After being put to bed he felt much better and the next day seemed quite normal with the exception of some bronchitis. The bronchitis cleared up in three days and the patient was X-rayed. A depressed fracture was seen in the left temporal region. By this time there were definite neurological signs of cerebral compression. The right grip was weak, the lower right abdominal reflex was absent and there was a right extensor plantar response. There was bilateral papilloedema. The patient had some hesitation in the choice of his words and occasionally used the wrong one.

November 7, 1930, thirteen days after admission, a vertical incision under local anaesthesia was made in the left temporal region and a depressed fracture exposed. On removing the depressed fragments of bone a large extradural clot was exposed which extended forwards for some considerable distance. The clot was removed and the dura mater examined, a small spicule of bone was found which had perforated the dura and entered the brain; this was carefully removed. The dura mater was incised but no hæmorrhage was seen inside the dura. The wound was closed, a drainage tube being used for twenty-four hours. The patient made a good recovery and was discharged on December 13, 1930, with no sign of cerebral abnormality.

CASE XI.—F. G. Y., male, aged forty-three years, a motor-driver by occupation, was admitted to hospital, October 16, 1931, after an accident in which his lorry collided with an oncoming van traveling in the opposite direction. Patient thought he hit his head on the windscreen; he did not lose consciousness.

At 2 P.M., when seen in the casualty department an hour after the accident, scalp wounds on the forehead, above and in front of the left ear and on the nose and chin were found. These were quite superficial and were stitched up. The patient was fully conscious and quite rational. He had no headache. The pulse rate was 90. A small clot of blood escaped from the nose, but there was no bleeding from the ears.

At 2.30 P.M. patient vomited a slight amount of blood; he also complained of pain on the left side of the face, which gave occasional twitches.

At 3.30 P.M. the patient was admitted to the observation ward. He became rather irritable, resistant and drowsy. Lumbar puncture was performed; deeply blood-stained cerebral-spinal fluid under moderate pressure was withdrawn.

At 9 P.M. the patient was definitely comatose. He could not be roused and was restless. The pulse was 56 and of good volume. Respiration 20 and shallow. Temperature 101° F. He vomited once or twice. Retention of urine had persisted since admission. Both pupils were small and reacted sluggishly to light. Subconjunctival hæmorrhage appeared in the right eye. Knee-jerks were present but sluggish. Bilateral extensor plantar reflexes were obtained. The blood pressure was 130/80. A diagnosis of cerebral compression due to a left middle meningeal hæmorrhage was made.

He was operated upon at 10.30 P.M. Fifty cubic centimetres of 20 per cent. sodium chloride was given intravenously. A large skin and muscle flap was reflected downwards in the left temporal region. The skull was trephined 1 inch above the centre of the zygoma, and the aperture enlarged to about 3 inches by 2½ inches by nibbling forceps. A large extradural clot was found and removed. A meningeal vein in the dura was under-run with a silk stitch. It was thought that this vessel was the cause of most of the bleeding. The dura was opened and blood-stained cerebral-spinal fluid escaped. The convolutions of the brain were indistinct, and the brain substance was

œdematous. The flap was replaced and sewn up without drainage. After the operation the pulse was 84, respiration 22, and the temperature 101°. Magnesium sulphate 2 drams was given over four hours.

The patient made a good recovery without complications, except for a left facial paresis which gradually cleared up. The temperature remained raised until the third day after the operation when it became normal.

The chief points of interest in this case are: (1) The pyrexia which persisted until the third day; (2) the bleeding which probably came from a vein rather than from an artery; (3) the absence of very definite localizing signs.

CASE XII.—E. D., aged fifteen years, a butcher's boy, was admitted to hospital July 20, 1932. The patient was diving and hit his head on the bottom of a swimming bath. He lost consciousness for a few minutes, but recovered and went home. Four hours later he collapsed and was brought to hospital in a semi-conscious state. On the way to the hospital he vomited in the ambulance. He had had a previous left temporal decompression following a head injury at the age of six years. This was performed at another hospital and no notes of the case were available.

When seen in the casualty department there was a small scalp wound over the left ear at the site of the old decompression. The pupils were equal but reacted sluggishly to light. Both knee-jerks and ankle-jerks were very brisk. A right extensor plantar response was elicited but that on the left side was doubtful. The patient became unconscious and had a series of right-sided Jacksonian attacks, consisting of twitching of the right side of the face and of the right limbs. The pulse was 72, respiration 28 and temperature 98°. A diagnosis of left-sided cerebral compression was made and an operation decided upon.

The operation was performed July 21, 1932, at 12.10 A.M. Intratracheal ether was given. A large skin and muscle flap was turned down at the site of the old decompression which had been completely covered in by bone. A small depressed fracture was found in this area. The skull was trephined in the left Rolandic region, and the wound enlarged with nibbling forceps. Spicules of bone which had perforated the brain substance through the dura were removed. There had been considerable bleeding from the dura which was dealt with and hæmostasis secured by under-running the bleeding vessels with silk ligatures. The patient made an uninterrupted recovery, except for a slight right facial paresis from which he eventually recovered. He was discharged from the hospital August 15, 1932.

CASE XIII.—Adeline M. M., an acromegalic, sixty-two years of age, was knocked down in the street by a motor-cycle August 19, 1933. The patient was not concussed, but had a fracture of the left tibia. She was brought up to the casualty department of King's College Hospital at 8.15 P.M., very shortly after the accident. On examination the patient was found to have a cut over the right wrist and a transverse fracture of the middle third of the left tibia which was confirmed by a skiagram. As the position of the fractured ends of the bone was excellent the leg was put up in plaster-of-Paris, no anæsthetic being used. While the plaster was being applied the patient vomited two or three times and complained of headache. The patient was admitted to the observation ward and an examination of the central nervous system did not reveal anything abnormal. The patient slept very well until about 4 A.M. the next morning, when the nurse noticed that the pulse had risen from 60 to 120 per minute. At 4.30 A.M. the patient was unconscious; the pupils were contracted and inactive to light, and the blood-pressure was 180/120. The right arm-jerks were increased while the left could not be obtained. The right knee-jerk was absent and a right extensor plantar reflex was elicited. The left knee-jerk and plantar reflex could not be tested as the leg was in plaster. Lumbar puncture was performed and 20 cubic centimetres of blood-stained fluid under pressure were withdrawn. The condition of the patient improved somewhat for an hour or so. At 7 A.M. lumbar puncture was again carried out and 20 cubic centimetres of blood-

## PROBLEM OF EXTRADURAL HÆMORRHAGE

stained fluid were again withdrawn but no improvement followed. At 7.30 A.M. both arms were flaccid with complete absence of reflexes. The right knee-jerk was absent but extensor plantar reflex was present. The right pupil was dilated and inactive, while the left one was small and reacted sluggishly to light.

At 11.15 A.M. a right subtemporal decompression was carried out under local anæsthesia. A large extradural clot was removed and a rent in the dura mater was enlarged and a subdural hæmorrhage exposed. The middle meningeal artery was tied. The condition of the patient immediately improved and the pulse rate came down to 112 and the volume was much better. However, at 1.30 P.M., some two hours after the operation, the patient suddenly collapsed and died.

At autopsy a long fissured fracture of the left parietal bone was discovered. There was some extra- and intradural blood-clot and some laceration of the right temporal pole. The anterior lobe of the pituitary contained a small cystic tumor. In all probability it would have been better in this case to have drained the subdural space as well as the more superficial wound.

An unusual feature about this case was the rising of the pulse rate.

CASE XIV.—H. P., female, aged fifty-five, was knocked down in the street by a motor-car and brought straight to hospital. When examined in the casualty department she was quite conscious. There was a wound four inches long in the scalp running across the left temporal bone diagonally. The pulse was 108 and poor in volume and tension. Respirations were 20, and the temperature 98° F. She was extremely collapsed and it was thought desirable to operate immediately on account of the large area of depressed bone.

*Operation.*—The wound was thoroughly cleansed and the skin edges excised and retracted. A piece of depressed bone about 2 inches by 1 inch was removed together with a large amount of extradural blood-clot. The dura did not appear to be tense. The patient was now in such a very serious condition that nothing more could be done, so the wound was packed and she was returned to bed. The patient did not rally and died twelve hours later. *Autopsy.*—A large extradural clot 3 inches by 3 inches was found below the area of the depressed fracture. There was laceration and slight hæmorrhage in the region of the tip of the right temporal lobe. In this case there was obviously much more blood-clot present than was thought to be the case at the time of the operation, although further exploration was contra-indicated at the time on account of the patient's general condition.

*Conclusion.*—(1) Every case of head injury should be admitted to hospital for observation and should be regarded as a potential case of extradural hæmorrhage, *e.g.*, in Case XIII the head injury might easily have been overlooked and the left leg having been put up in plaster the patient sent home. This case actually proved to be one of very gross extradural hæmorrhage.

(2) *Localizing signs.*—In some cases it is difficult to determine the side of the hæmorrhage; in fact, in some instances the hæmorrhage may be due to a bilateral lesion, *e.g.*, Case III.

In our series of cases the following features may be regarded as important:

(a) The presence of a local skull injury, *e.g.*, hæmatoma.  
(b) *Pupils.* Usually the pupil on the side of the hæmorrhage is dilated and fixed and the contralateral pupil small and active by the time the patient's condition has indicated operation.

(c) Contralateral hemiparesis with extensor plantar response and absent abdominal reflexes.

# WAKELEY AND LYLE

SUMMARY OF CASES

Patient	Age	Nature of Injury	Cerebral Condition	Localized Injury	Pulse Rate before Operation	Localizing Signs	Lumbar Puncture	Operation	Result
1. George H.	17	Hit head on curb, knocked down by motor-cycle.	Became drowsy after half an hour. Not unconscious.	Hæmatoma left side of head.	60	Aphasia. Twitching of right hand.	Yes. Blood-stained.	Left temporal decomp. Small extradural clot. Middle meningeal artery tied. Dura not opened.	Complete recovery.
2. William B.	26	Hit head on iron stanchion.	Unconscious 1½ hours after injury. Vomited copiously.	Contusion at right external angular process.		Nil.	Yes. Blood-stained, under considerable pressure.	Right subtemporal decomp. Large extradural clot. Dura not opened.	Died in 12 hours. Autopsy. — No other intracranial hemorrhage. Brain œdematous.
3. John H.	32	Fell 10 feet head first into a picket boat.	Conscious. Headache and vomiting after one hour, then unconscious.	Nil.	52	Bilateral subconjunctival hemorrhages. Right facial palsy. Weakness of right arm.		Right subtemporal decomp. Large extradural clot. Brain bruised. Dura not opened.	Died 12½ hours after operation. Autopsy. — Considerable extradural and intradural hemorrhage on left side. Complete recovery.
4. George A.	23	Blow on head from traveling crane.	Unconscious. Later just conscious.	Large lacerated wound right temporal region.	58	Jacksonian attack starting in left hand. Weakness of left arm.		Right temporal decomp. Depressed portion of bone removed. Large extradural clot. Dura opened.	Complete recovery.
5. Charles H.	15	Knocked down by motor-cycle.	Concussed. Unconscious 17 hours later.	Bruise right temporal region.	60	Right pupil dilated, and inactive, left pupil small and active		Right subtemporal decomp. Large extradural clot; middle meningeal artery ligated.	Complete recovery.
6. Charles H.	40	Knocked down by tram.	Unconscious.	Deep scalp wound 2 inches in left parietal region.	40	Left pupil dilated. Bleeding from nose.		Excision of wound edges. Left subtemporal decomp. Large extradural clot.	Complete recovery.
7. Barbara W.	6	Knocked down by car.	Unconscious. Later restless and vomited.	Right parietal hematoma.	60	Facial twitching.		Right temporal decomp. Large extradural clot.	Complete recovery.
8. John H.	12	Fell from window onto pavement, 18 feet.	Conscious. Unconscious 10 hours later.	Hæmatoma, left parietal region.	66			Left temporal decomp. Large extradural clot.	Complete recovery.

# PROBLEM OF EXTRADURAL HÆMORRHAGE

9. Joseph H.	21	Kick right side of head by horse.	Unconscious. Conscious 2 hours, 50 mins. after injury.	Hæmatoma right temporo-parietal region.	60	Right pupil dilated. Paralysis of left arm.	Right subtemporal decomp. Large extradural clot. Foramen spinosum plugged with match. Dura opened.	Complete recovery.
10. Fred'k W. J.	71	Knocked down by car.	Dazed.	Pain in left temporal region.		Three days later: Weakness of right grip. Right plantar extensor response. Bilateral papilloedema. Right lower abdominal reflex absent. Dysphasia. X-ray.—Depressed fracture left temporal region.	Left temporal decomp. Depressed bone removed. Large extradural clot. Dura opened.	Complete recovery.
11. F. G. V., male	43	Lorry accident. Hit head on windscreen.	Conscious. Later irritable and drowsy and then comatose.	Scalp wound on left forehead.	56	Left facial twitching. Right subconjunctival hæmorrhage. Bilateral extensor plantar responses. Knee-jerks sluggish.	Left temporal decomp. Large extradural clot. Middle meningeal vein tied. Dura opened.	Complete recovery.
12. E. D., male	15	Dived into swimming bath and hit head on bottom.	Unconscious for a few minutes then conscious, 4 hours later semi-conscious.	Left scalp wound.	72	Right plantar response extensor. Left doubtful. Right Jacksonian attacks.	Left temporal decomp. Vessels underrun.	Complete recovery.
13. Adeline M. M.	62	Knocked down by motor-cycle.	Conscious. Later vomited and headache. Unconscious 8 hours later.	Nil. Fracture left tibia.	120	Pupils small and inactive. Right arm-jerks +. Left arm-jerks -. Right plantar reflex extensor. Right knee-jerk -. Later right pupil wide and inactive. Left small and active. Both arms flaccid.	Right subtemporal decomp. Middle meningeal artery tied. Large extradural clot, subdural clot.	Died. Autopsy.—Some extra- and intradural clot. Laceration of right temporal pole.
14. H. D., female	55	Knocked down by car.	Unconscious.	Left temporal wound and depressed fracture.	108		Removal of depressed bone. Right temporal decomp. Large extradural clot. Dura not opened.	Died. Autopsy.—Large extradural clot. Laceration and hæmorrhage at right temporal lobe.



(d) Contralateral Jacksonian attacks.

(e) If left-sided (in a right-handed individual) varying degrees of aphasia or apraxia.

(3) Note the absence of post-concussional syndromes in patients who have been subjected to decompression.

The question naturally arises, "Should decompression be done more frequently in cases of injury to the skull?"

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## INFLUENCE OF ELEVATIONS OF THE BASIS CRANII INTERNA UPON OPERATIVE APPROACH TO THE SELLA TURCICA

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THE intracranial approach to the sella requires a strict selection of suitable conditions for it (the supracellar forms of tumors). Besides, apart from such matters as localization of the tumor, its size, its correlation to the surrounding parts and the degree of the increase of the intracranial pressure, anatomical factors must also influence the complications of the operation.

The elevation of the brain (its frontal and temporal lobes via anterior and mesial cranial fossæ) is both a difficult and a delicate step in the intracranial approach. The history of this operative approach has shown that the difficulties of this step alone made one interrupt the operation without reaching its object, or produced more or less grave injuries of the cerebral substance. Amid the anatomical factors which can affect this step of the operation, attention has up to now been paid to the distances to the sella turcica, anteriorly—from the side of the forehead; laterally—from the temporal region. The measuring of these distances (Gibson, Cope, Schulz, Astroff) has shown that they depend but little upon the shape of the skull. Cope states that the anterior distance (nasion-sella) is equal to sixty millimetres and the lateral distance to fifty millimetres. Astroff has found that these distances may be the same for the skulls of different and even extreme forms; anteriorly (offrion-sella) they average sixty-seven millimetres in dolichocephals, sixty-two millimetres in brachycephals; the lateral distance (pteryon-sella) averages fifty-three millimetres in dolichocephals, and sixty millimetres in brachycephals. Thus the longitudinal distance exceeds the transverse one by fourteen millimetres in dolichocephals and by two millimetres in brachycephals.

The absolute dimensions of the distances to the sella are of a certain significance for the operative approach. Some one-half or one centimetre of the additional depth, which are to be overcome towards the object of the operation, largely increase the distance to which the brain is to be declined from the skull base. But apart from the form, the size of the skull should have its influence on these absolute dimensions. At the same time, it is expedient to take these measurements from the plane above the supra-orbital ridge, as this plane is the initial one for the operative approach. Of no lesser, if not greater, importance is it to ascertain the variations of the elevations of the skull base, which may have influence on one of the essential moments of the operative approach—on the mobilization, that is, the elevation of the brain from the skull base.

For this reason researches were carried out in the Museum of Anthro-

pology and Ethnography of the Academy of Sciences (Great-Russian skulls being preferred).

*Method of Research.*—The external measurements (those of length, breadth, height, horizontal circumference, sagittal arch, bi-auricular breadth of the base and the minimum breadth of the forehead) were taken after Martin. Fixation was done in the cubus-craniophore, the plotting of the basic and upper horizontals after Krönlein. The anterior border of the object of the operation was characterized by sphenoidal (sph Fig. 1\*).

The lateral distances (B-sph) were computed from the intersection of the frontal plane through sphenoidal with the upper horizontal (B). The location of the "bordering arch" between the front and middle cranial fossa ( $d$ ,  $d_1$ ,  $d_2$ ) was determined in relation to this plane.

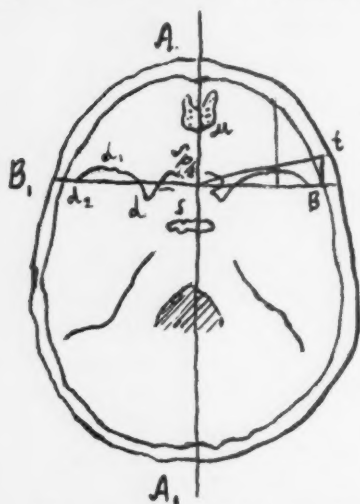


FIG. 1.—Basis cranii interna. Diopetrograms. The complex relief of the bordering region. Sph—Sphenoidale.  $d$   $d_1$   $d_2$ —The bordering arch. B B<sub>1</sub>—The frontal plane through sphenoidale.

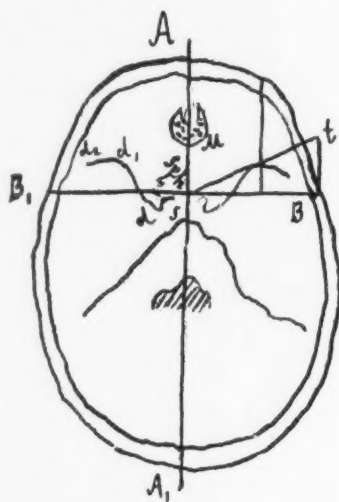


FIG. 2.—Basis cranii interna. Diopetrograms. The simple relief of the bordering region.

Below the bordering arch the great wing of the sphenoid bone formed a niche ("the bordering niche") in the medial section of which there is the fissura orbitalis superior. This niche was characterized by sagittal curves, taken by means of a diagraph in its medial, middle and lateral thirds. (Fig. 3.) The curves in the frontal planes through the middle of the anterior cranial fossa (Fig. 6), those through the bordering arch (Fig. 5), and through the middle cranial fossa at the level of the sella turcica (Fig. 7), were also taken by means of the diagraph.

Seventy skulls were used for taking seventy diopetrograms (in norma horizontali, Figs. 1 and 2), for 600 curves plotted by means of a diagraph, and for over 2,000 measurements.†

\* The anterior distance (A-sph) to this point were calculated from the intersection of the sagittal plane through sph with the upper horizontal.

† The material was worked up by the method of the variation statistics. The sign  $\pm$  indicates the probable errors; A—average value; B—quadratic deflexion; C—coefficient of variation; r—coefficient of correlation.

## ELEVATIONS OF BASIS CRANII INTERNA

### *Relief of Basis Cranii Interna*

(I) *Bordering Region (Arch and Niche)*. The relief of the bordering niche (Fig. 3) is characterized by the diagraphic curves taken in sagittal plans through the medial, middle and lateral thirds of the niche.

The middle curve projects forward below fossa cranii anterior more than the other ones. The depth of the niche in this section is indicated by the arrow  $dc$ ; ratio  $\frac{dc}{ab} \cdot 100$  provides the index of this depth. The index ranges within wide limits from 16,0-52 its average value being  $A=33,8 \pm 0,67$ . The comparison of the distant variants (Figs. 3A and B) with the indices 42,9 and 23,3 gives in one case (B) a shallow niche, that is, the transition of the anterior cranial fossa into the middle one with a slight bent. In other words, it gives a simple relief in contrast to the deep niche, *i.e.*, the complex relief in

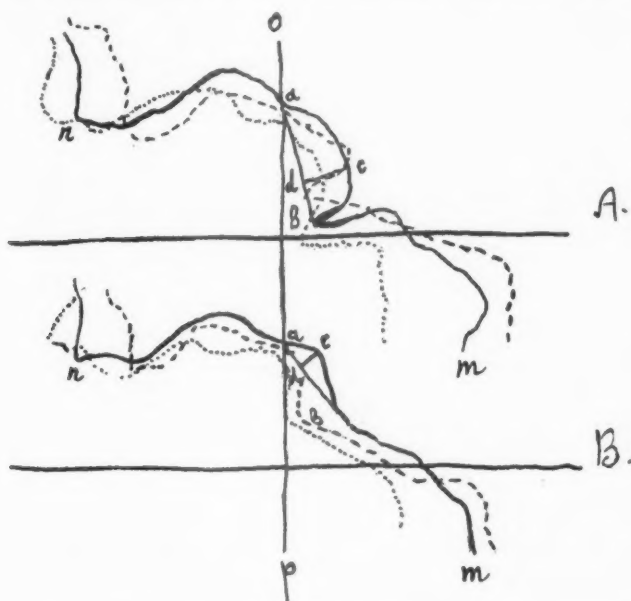


FIG. 3.—The sagittal sections through the bordering niche (diagraph). (A) complex, (B) simple relief of bordering region, — through the middle third, — — — through the lateral, . . . through the medial third of the niche; (mb) fossa cranii anterior; (b) the margin of the small wing; (bca) the bordering niche; (n) the spine of the pyramid; (op) the frontal plane through sphenoidal (sph—Fig. 1).

another case (A). The extreme forms are connected with one another by a row of gradations. The coefficient of variation is  $C=20,9$  per cent.  $\pm 1,2$ , which indicates a wide range of fluctuation in the nature of relief ( $6 = \pm 7,08 \pm 0,4$ ). The differences between the distant variants catch one's eye at the direct examination (photographs of respective skulls, Fig. 4). In general, the niches below the average size (plain relief, the index being less than 30,2) have been met in 24,3 per cent. of cases, the niches of average depth (index\* 30,2-37,3) in 41,4 per cent. and deep niches (complex relief, the index being over 37,3) in 34,3 per cent. of cases. In other words, something less than one-half of cases fall to the middle group, while one-quarter and one-third of all cases fall to the deviation from it, *i.e.*, to the plain and complex relief, respectively.

The curvature of the bordering arch  $\sqrt{(\text{diptograms, Figs. 1 and 2})}$  furnishes all the gradations beginning with the sloping shape (Fig. 1) and finishing with the arch,

\* Indices of the middle groups have been taken according to the formula  $A \pm \frac{6}{2}$ .

which projects sharply towards processus orbitalis. Fig. 2.) Accordingly, the angle of the operative approach changes within the limits of anterior fossa cranii (L A.sph.t). The variations of this angle may amount to  $19^\circ$  (from  $82^\circ$  to  $63^\circ$ ). The arch curvature itself is determined by the index  $\frac{AB}{\text{sph. B}} (= \text{tg } \angle \text{tsph.B}) \cdot 100$ . This index varies also within a wide range from 15,0 to 51, the average value being  $A=27,6 \pm 0,55$ ;  $B=\pm 6,834$ ;

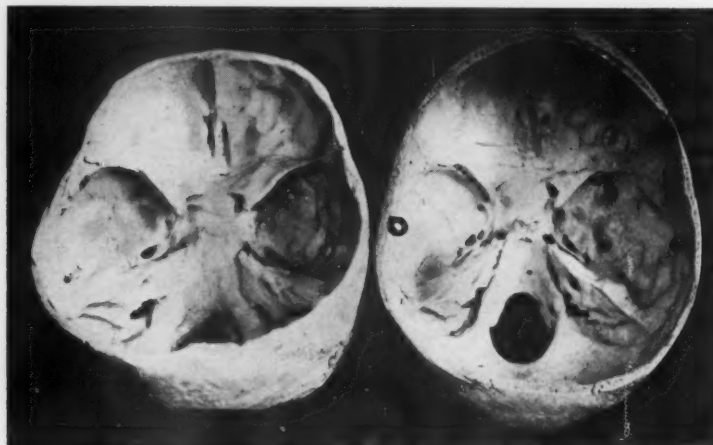


FIG. 4.—The photographs of the skull with the complex (left) and simple (right) relief of the bordering region.

$C=24,7$  per cent.  $\pm 1,5$ . This also makes clear the relation between the shape of the bordering arch and the depth of the bordering niche (coefficient of correlation  $r = -0,33 \pm 0,07$ ): a considerable curvature more often corresponds to the shallow niche (plain relief, Fig. 3B, Fig. 4, at right, Fig. 2), a sloping bordering arch corresponds mostly to the deep niche (complex relief, Fig. 3A, Fig. 4, at left (Fig. 1).

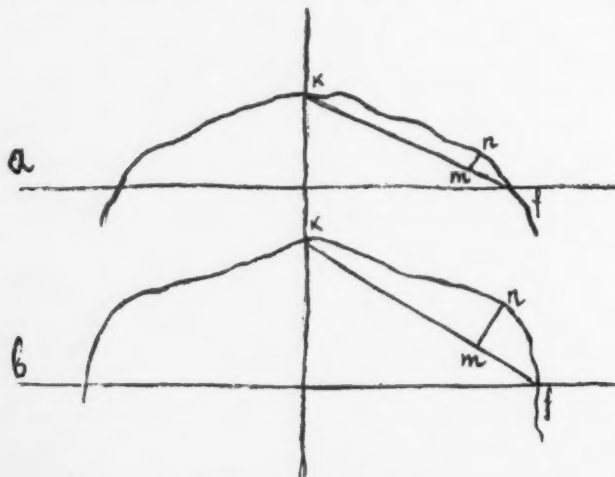


FIG. 5.—The curvature of the small wings in the frontal plane (diagraph); (a) small, (b) big curvature.

The dependence of the relief of the bordering region (bordering arch and niche) upon the exterior skull shape was expressed by a small value of the coefficient of correlation of the respective indices with the main indices of the skull. It may only be said that the extreme groups (plain and complex relief) have been met with in the dolichocephalic



## ELEVATIONS OF BASIS CRANII INTERNA

skulls in the same number of cases (29 per cent.) while in the brachycephalic skulls the complex relief (44 per cent.) prevails over the plain one (26 per cent.).

In the same bordering region the curvature of the small wings in the frontal plane (Fig. 5) furnishes a relatively smooth relief of the approach to the saddle from the level of the horizontals, even in the case of the extreme variants (Figs. 5a and b). The index  $\left(\frac{mn}{kf} \cdot 100\right)$  ranges from 6,0—24,0 ( $A=16,2 \pm 0,28$ ;  $6=\pm 3,57 \pm 0,2$ ;  $C=22$  per cent.  $\pm 1,3$ ;

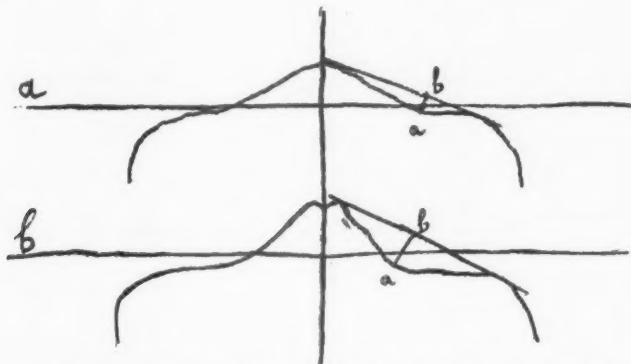


FIG. 6.—The frontal sections through the fossa cranii anterior (through the point "u") (Figs. 1 and 2). Diagram (a) simple, (b) complicated relief of the processus orbitalis.

the correlation with the cephalic index  $r=-0,27 \pm 0,07$ . In this case and especially for the middle fossa cranii one gets the impression that the skull which is narrowed laterally has a more concave base.

(II) *Fossa Cranii Anterior*.—Fossa cranii anterior is characterized by the frontal sections which pass through the posterior portion of lamina cribrosa. (Fig. 1, point M in

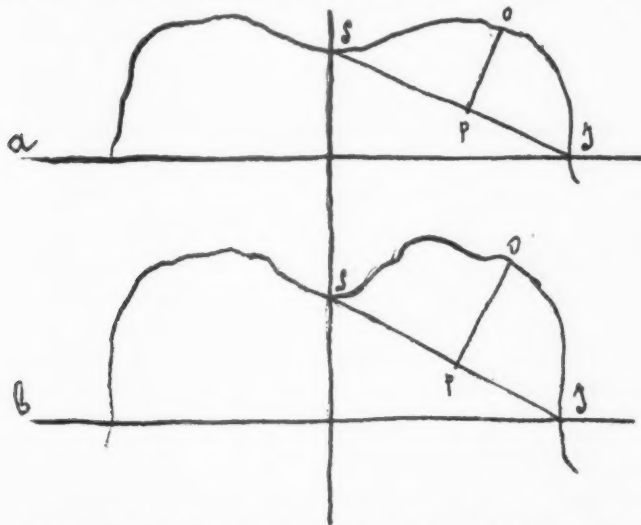


FIG. 7.—The frontal section through the middle cranial fossa on the level of the sella (diagraph); (a) shallow, (b) deep fossa.

the middle between A and sph.) Here also the study of the curves allows one to distinguish the forms with a relatively smooth relief (Fig. 6a) and those with a complex relief (Fig. 6b). In the latter case the orbital process projects into the cranial cavity having a more or less steep medial slope according to which the adjoining part of the frontal lobe is found to be situated in a deep groove formed in by the lamina cribrosa. The majority of

cases fall to the complicated relief (30 per cent.) while to the plain one there falls only 18 per cent. (Index ab—from three to eleven millimetres;  $A=6,25\pm0,1$ ;  $6=\pm1,43\pm0,08$ ;  $C=23$  per cent.  $\pm1,3$ .)

(III) *Fossa Cranii Media*.—The outline curvature of the frontal plane represented by the index  $\frac{Dp}{ss}$  100 ranges from 32 to 53 ( $A=40,8\pm0,29$ ), its variations (Fig. 7) being within lesser limits than those of the indices mentioned above ( $6=\pm3,69\pm0,2$ ;  $C=9$  per cent.  $\pm0,5$ ). The correlation with the cephalic index ( $r=-0,4\pm0,06$ ) shows that with the decrease of the distance from the sella in the dolichocephalic skulls the curvature of the outline increases. The relief becomes simplified at the approach from the level of the lower horizontal, though the required displacement of the temporal lobe remains significant owing to the elevating of the base towards the sella turcica.

(IV) *Distance up to the Sella*.—The anterior distance (A sph. Figs. 1 and 2) was confined to the limits of fifty-four to seventy-two millimetres ( $A=61,08\pm0,27$ ;  $6=\pm3,36\pm0,2$ ;  $C=5,5$  per cent.  $\pm0,3$ ). In this case the correlation with the cephalic index is relatively small ( $r=-0,24\pm0,07$ ), because the size of the skull is not taken into consideration. To a far greater extent this distance depends upon the maximum length of the skull (db-op); in this case the coefficient of correlation is  $r=\pm0,52\pm0,5$ . The lateral distance (B sph, Figs. 1 and 2), having extreme values of 53 and 68, showed an average value very closely approaching that of the average anterior distance ( $A=59,43\pm0,24$ ;  $6=\pm3,08\pm0,24$ ;  $C=5,18$  per cent.  $\pm0,3$ ). Here the coefficient of correlation being but little dependent upon the cephalic index ( $r=+0,24\pm0,07$ ) has been also considerably increased when compared with the maximum breadth (eu-eu) of the skull ( $r=+0,57\pm0,05$ ).

The above data show that these distances are to be taken into consideration when operating on the dolichocephalic skulls via the anterior approach, while via the lateral they play an important part only for the large brachycephalic skulls. The size of the skull is undoubtedly to be taken into account.

*Influence of the Relief Peculiarities upon the Operative Approach*.—The influence of these peculiarities has been made apparent by means of operations on cadavers. The criterion of the satisfactory approach on a cadaver is as follows: The cadaver should be placed with its head hung loosely downwards and without applying the instruments to press down the brain; the operative field should comprise the optic nerves, their chiasma, the spatium præchiasmaticum—the most common localization of the operable tumor—and if possible the carotids. Apart from the possibility of introducing an instrument into the sella turcica, all of these components of the operative field should be within reach of a finger; besides no trauma of the brain should take place even in the form of any laceration of the pia. Some drawings, illustrating several movements of the operation, were made through a frosted glass.

*Trepanation within the Temporal Frontal Quadrant*.—The sagittal side of the osseous frame in a complete temporal frontal quadrant is located parallel to the sagittal suture at a finger's distance from it; the horizontal side does not reach the upper horizontal of Krönlein by the same distance as well as the frontal side in relation to the linea bi-auriculari.

In case of the anterior approach the conditions of the mobilization of the anterior portion of the frontal lobe are unfavorable. In its medial part, this portion is situated the deepest, corresponding to the slope of the processus orbitalis towards the lamina cribrosa. Its peeling out from this groove is difficult.

## ELEVATIONS OF BASIS CRANII INTERNA

Of no little importance is also the fact that just this deeply situated portion is fixed to the adjoining frontal lobe by means of a callous body. The laceration of the pia mater and the cortical layer most readily occur just in this portion when the complicating projection of the processus orbitalis is present. The hindmost portion of the frontal lobe adjoining the temporal one (or "the bordering region of the brain," called so by its analogy to the corresponding portion of the skull base) is the easiest to elevate from the base of the skull. Following the smooth posterior margin of the fossa cranii anterior according to the plain relief of this region (Fig. 4) one may easily and rapidly enough introduce the finger as far as the optic nerve. Here it proves that the conditions of the brain mobilization change essentially according to the prominence of the bordering region of the skull base. Some drawings are demonstrative enough in this connection. These drawings were



FIG. 8.

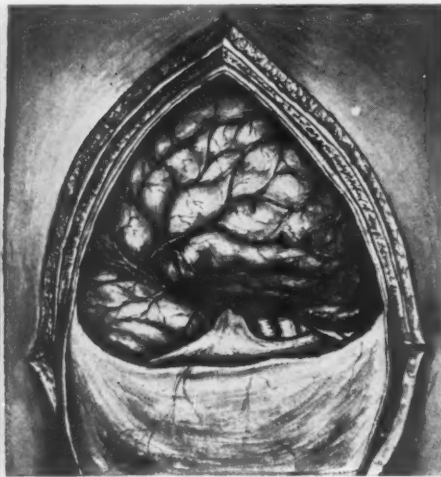


FIG. 9.

FIG. 8.—The approach through the fronto-temporal quadrant when the relief of the bordering region is simple.

FIG. 9.—The approach when the relief of the bordering region is complicated.

made from the objects closely resembling one another as to dimensions and forms of their skulls, but largely differing in the relief of the bordering region.

Having taken off the flap of dura mater one may become convinced that at every attempt of elevating the posterior portion of the frontal lobe (resp. "bordering region of the brain") the latter is followed by the anterior pole of the temporal lobe hidden in the bordering niche. If the relief is plain the temporal lobe is easily removed from the shallow niche (Fig. 8), the bordering region of the brain base gets off considerably from the skull base, and in the operative field there are widely exposed the optic nerves, their chiasm, the spatium præchiasmaticum arteria carotis. A slight removing of the temporal lobe backwards (which is easy owing to the anterior pole having projected from the niche) is sufficient to expose the lateral wall of sin.

cavernosi and oculomotor nerve. Veins running from the pole of the temporal lobe towards the sinus are easily accessible for the ligature in the wide operative field.

While elevating the bordering region of the brain in case of a complex bordering outline (Fig. 9) the anterior pole of the temporal lobe is left in a deep niche; in this instance some kind of a second punctum fixum is produced (the first one—at the medial margin of the frontal lobe—has been mentioned above). If the complexity of the relief is well pronounced one fails to remove the pole of the temporal lobe either by a finger or by an instrument without having injured it. Consequently, the operative field is considerably narrower and its deep components (such as nervi optici, spatium præchiasmaticum) are exposed at a much lesser angle.

From this point of view the analysis of the frontal temporal routes (Krause, Bogoyavlensky, Kupp, Hildebrand, Spasokukotsky) has shown that the approach to the object of the operation is the most profitable in the bordering region along the smooth relief of the posterior part of the fossa cranii anterioris. Here it is expedient to extend the posterior side of the osseous flap as far as the linea bi-auricularis. In case of a complex relief of the bordering region the exposure of the temporal lobe provides conditions for the mobilization of the anterior temporal lobe pole. Anteriorly, the boundaries of the osseous frame should not pass beyond the middle of the supra-orbital ridge. A further widening anteriorly up to the sagittal arch is unexpedient, because the above-mentioned peculiarities of the projecting orbital process and of the fixation of the medial portion of the frontal lobe add nothing to make the approach wider. In skulls of a plain relief of the bordering region one may obtain a good approach within the limits of the osseous frame which does not extend into the frontal region.

*Trepanation within the Limits of the Frontal Region.*—With the osseous frame which does not extend beyond the supra-orbital ridge, one always fails to obtain as wide an approach to the object of operation as that in the case of frontal temporal routes owing to the peculiarities of the orbital process and of the frontal lobe fixation. The conditions are especially unfavorable if the extradural route be used (Krause) where the operative field is limited at its sides by the borders of the orbital process (fields of the fixation of dura). When operating along the intradural route a considerable pressing of the frontal lobe upwards into the cranial cavity is required, whereby lacerations are readily produced in the medial part of its base.

The influence of the unfavorable peculiarities of the relief in the region of fossa cranii anterior is excluded when using the bilateral frontal route (Kiliani, McArthur, Unger). If in this case the osseous frame extends at both sides as far as the frontal temporal margin, and if its upper part reaches the coronal suture, a wide approach is obtained at the intersected falx cerebri. The plane which fixes the base of the brain passes through the bordering niches and optical nerves thus retreating backwards. The part of the frontal lobe which being deeply situated is found to be fixed (when

## ELEVATIONS OF BASIS CRANII INTERNA

using the unilateral frontal route) by means of the corpus callosum, in case of a bilateral route is elevated together with the adjoining frontal lobe. Thus this route, being undoubtedly more traumatic than the frontal temporal one, is to be kept in view when the conditions are unfavorable for the frontal temporal approach. At such conditions one should consider the presence of a complex relief of the bordering region in a big brachycephalic skull.

Since the width of the approach and its choice appear to be dependent upon the relief of the skull base, especially of its bordering region, the determination of the relief by the shape of the skull would be highly desirable. However, no correlation between the relief of the bordering region and the skull indices has been discovered (small coefficient of correlation). Accord-

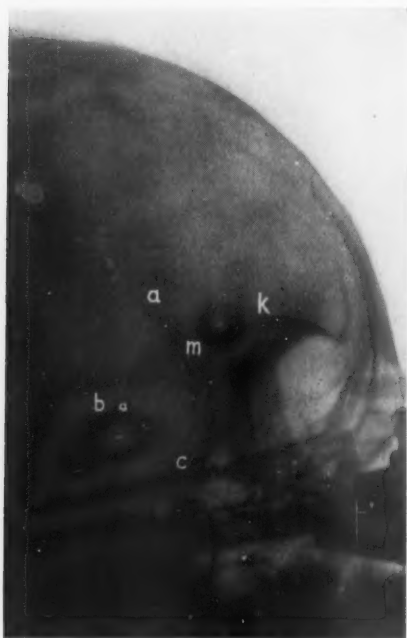


FIG. 10.—The complex relief of the bordering region.



FIG. 11.—The simple relief of the bordering region.

ingly, there was worked out the method of the röntgenographical determination of the relief of the bordering portion.

The röntgenograms were at first taken from the skulls which were strictly fixed in space, some points of the skull base being controlled by the wire. This permitted one to proceed in future with the photographing of the skulls without any special apparatus for fixing them in space and with no fear of the incorrect interpretation of the obtained pictures. The photo plate is given an inclination of about  $15^\circ$  to the horizontal plane. The person to be photographed lies down with the side of his face upon the plate in such a way that the normal lateralis cranii is as parallel to the plate as possible. The basic horizontal (Krönlein) should be approximately parallel to the upper edge of the plate. The tube is centred at a finger distance backwards from bregma.



Under these conditions (Figs. 10 and 11) the contour of the bordering arch (the margin of the small wing) is seen as a soft convex line (ab). In front of this line there is situated another convex line of a more distinct character (me). This line corresponds to the junction of the frontal bone with the wings of the sphenoid bone, and to the junction of the small wing with the body of the sphenoid bone. In this way it provides the anterior border of the osseous canopy over the niche or the projection of the niche bottom. The roof of the orbit approaches the same line anteriorly (km).

Figures 10 and 11 show how the extreme forms of the structure of the bordering region are reflected upon the röntgenogram. In case of a complex relief (Fig. 9, Fig. 4 at left) the sloping, bordering line together with the projection of the niche bottom forms a high triangle, the anterior side of which in the middle of its extension is approached by the line km. In case of a plane relief (Fig. 10 and Fig. 4 at right) the bordering arch runs with a sharp bend forward, its junction with the anterior arch takes place at the point where the line km approaches it anteriorly and the triangle of a small height does not extend above that line. All transitional stages between two extreme variants found in living objects are shown in Fig. 12.

SUMMARY.—(1) In case of the intracranial route the width of the operative approach is affected by the relief of the basis cranii interna.

(2) Most important plan and complex forms of the prominences of the bordering region of the basis cranii interna may be determined röntgenographically.

(3) The frontal temporal route limited by the middle of the supra-orbital margin anteriorly and by the linea bi-auricularis posteriorly is expedient. In this case the sella is to be approached along the posterior region of the fossa cranii anterioris.

(4) In large brachymorphous skulls which have a complex relief of the bordering region, a wider approach may be provided by the bilateral (though more traumatic) route limited by the zygomatic process of the frontal bone laterally and by the coronal suture from above.

NOTE.—I wish to express my gratitude to Prof. V. N. Sherkunenko for his erudite indications in my work.

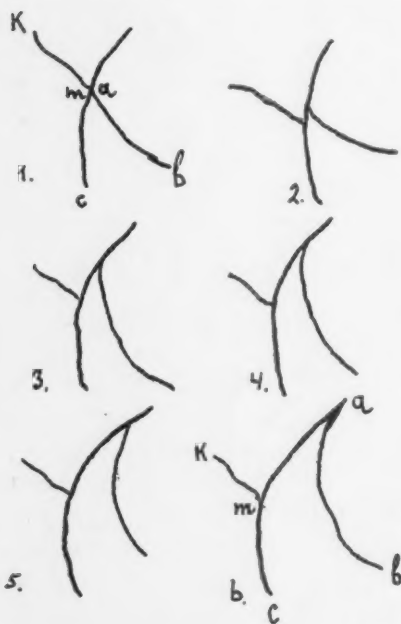


FIG. 12.—Scheme of transition from the most simple (1) to the most complicated (6) from the studied forms of the bordering region; obtained by means of the röntgenography of living objects.

## ALCOHOL INJECTIONS OF THE GASSERIAN GANGLION FOR TRIGEMINAL NEURALGIA

By I. M. IRGER, M.D.

OF MINSK, RUSSIA

FOLLOWING the publication in the ANNALS OF SURGERY of November, 1930 (vol. 92, p. 984), of my article on a method for penetrating into the Gasserian ganglion, read before the twenty-first Russian Surgical Congress of that year, two papers, one by Härtel and a second by Kirschner, have been published in the Zentralblatt für Chirurgie, No. 6, 1933, criticizing the procedure outlined in my paper.

Defending his method, Härtel emphasizes in his article that complications may happen if one is not sufficiently acquainted with the technics of the procedure. He simultaneously makes objection against my method, which is defended by Kirschner. The latter names the method of Härtel supra-mandibular, that of mine inframandibular.

Härtel asserts that the method used by him during twenty years has never needed modifications, while "the method of Irger is based on a pure theoretical construction and has until the publication of the former never been verified on men." Though admitting the possibility of penetrating to the Gasserian ganglion from the angle of the lower jaw, he demands that the expediency of this method be proved on clinical material. It seems to Härtel, though he has not verified it, that the path of penetration of the needle after my method would be longer than after the one employed by him. But making objection to Härtel, Kirschner maintains the expediency and simplicity of my method, which he first verified on patients while I had worked it out only on cadavers. He used my method in twenty-five cases without any complications.

Concerning the length of the path from the skin prick to the Gasserian ganglion Kirschner could not find any essential difference between my method and that of Härtel on either skulls or patients.

In using the method of Härtel, verified on cadavers and patients, we could not confirm the correctness of penetrating into the ganglion; that is why we began to search for another method.

Offerhaus noted in his day that the oval foramina and the articular tubercles were on a same line. Uniting, according to our researches, by direct line the angle of the lower jaw, the upper margin of the articular tubercle and the oval foramen, we get an isosceles triangle with the top at the angle of the lower jaw. Consequently, the distance from the angle of the lower jaw to the oval foramen will be equal to the distance from the former to the upper margin of the articular tubercle.

The examination of fifty skulls has enabled us to affirm that these deductions are quite true. Now as it is quite easy to determine in everyone the

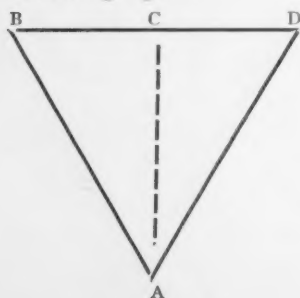
distance from the angle of the lower jaw to the upper margin of the articular tubercle, so one can calculate *a priori* the depth from the puncture of the needle to the oval foramen. Our examinations proved that the maximal possible failure equals 1 to 2 mm., which is of no real importance. According to our researches the arithmetical average of the distance to find equals 6.4 cc.

Comparing the two methods following ours one can in every case beforehand fix the distance from the angle of the lower jaw to the oval foramen while in the procedure of Härtel there are no points to rely upon for accurately measuring the distance from the initial point to the oval foramen. After Härtel the arithmetical average of the distance to find equals 5.7 cc. It is evident that the distance can be of considerable variability and depends upon the skull form.

The technic of penetrating to the Gasserian ganglion after our method is the following:

Half an hour before the operation a morphine injection is given. The skin of sensible individuals can be anæsthetized. The patient lies upon the operating table, his head hanging downward and fixed by an assistant. One previously marks by an ink-pencil the line joining the upper margin of the articular with the angle of the lower jaw, the mouth of the patient being tightly closed. Covered with iodine the violet line of the pencil becomes very marked. For injections we use needles 10 to 15 cc. long and 0.8 mm. thick. The needle is furnished with a bar, which could be replaced by a cork or a caoutchouc. We measure from the point of the needle to the bar a distance equal to that from the angle of the lower jaw (the mouth of the patient being closed) to the upper margin of the articular tubercle and we introduce the needle into the skin of the internal plane of the lower jaw angle. The point of the needle has to touch the bone. The needle will be then slowly advanced to the bar following the direction of the skull base. To verify whether the needle really advances to the oval foramen the following data shall be taken into consideration; the needle can be declined in sagittal or frontal direction. To avoid the sagittal deviation one has to remember that the articular tubercles and the oval orifices are upon one line; the prolonged direction of the needle must so coincide with the line uniting the puncture point with the upper margin of the articular tubercle, *i.e.*, with the pencil line.

The frontal deviation (inwards) must be avoided by considering the following figure:



A—Angle of lower jaw.

B—Upper margin of the articular tubercle.

D—Oval orifice.

AC—Ascending ramus of the lower jaw.

## ALCOHOL INFECTIONS OF GASSERIAN FUNCTION

The angle of the lower jaw (A) can, as mentioned, be regarded as the top of an isosceles triangle, the sides of which are formed by lines joining the mentioned angle with the articular tubercle (B) and the oval orifice (D).

As AC (the sagittal plane of the ascending branch of the lower jaw) draws perpendicularly to BD, the angle CAD equals BAC, *i.e.*, the angle of deviation of the needle (AD) from the ascending branch of the lower jaw equals the angle of deviation from the latter of the "pencil line." That is to say, the frontal deviation (inwards) of the needle is of no significance; it amounts on an average a 22 angle.

When treating the question from the practical point of view one has to keep in mind that at first the needle point deviates a little to the median line till it does touch the planum infratemporale. By advancing the needle point one reaches necessarily the oval foramen. The distance from the oval foramen to the upper margin of the pyramid of the temporal bone varies, according to Härtel, from 19 to 23 mm., the minimal distance being 14 mm. The distance from the oval foramen to the Gasserian ganglion is equal on the average following our examination to 1 cc. This is why the needle after reaching the oval foramen has to be advanced upward to a distance of 1 cc. The gliding of the needle when using the method of Härtel can be explained by the impossibility to definitely establish the distance to be found. From this point of view our method merits attention as we can in every case calculate beforehand the distance to the Gasserian ganglion.

By using our method we avoid the wounding of vessels. The external and internal carotid and jugular vein pass behind and outside from the needle. The internal upper jaw artery is bent upon the lower jaw and disposed outwardly from the passage of the needle making its way on the external surface of the external pterygoid muscle. At the perpendicular and horizontal sections the cavernous sinus has the shape of a triangle with the base upward and the top downward. From the surgical point of view the most interesting is the external partition as on it pass (from top to bottom) N. trochlearis, the first branch of the N. trigeminus, N. oculomotorius, N. abducens. The internal carotid artery also perforates the external partition of the cavernous sinus.

Following the method of Härtel and of Harris the needle can easily get into the cavernous sinus and wound the above-mentioned nerves and vessels. That has happened more than once and caused serious complications.

Following our method we direct the needle upward and so avoid the sinus, which our examinations of cadavers demonstrated.

Beyond any doubt the alcohol injections should be performed on cadavers before being practised on men, the penetration into the Gasserian ganglion being an achievement of adequate experience.

We report six cases in which there were made fourteen injections.

CASE I.—E. M., aged seventy years, peasant woman, admitted September 9, 1930, complaining of neuralgia along the right trigeminus nerve. The first onset occurred two years ago after an extraction of the right lower molar tooth. Intense pain con-

tinued the whole time and made the patient incapable of sleeping and eating. She had been treated by different physiotherapeutic methods.

X-ray and mouth examination revealed no source of the pain. The nerve trunks are very painful when touched in the right forehead, face and temporal region. The patient cannot sleep despite narcotics.

September 12. Two cc. alcohol injections into the right Gasserian ganglion. The patient was sleeping without any narcotics.

September 30. Alcohol injection repeated because of disagreeable feelings in the skin of the face.

Thereafter the pains totally disappeared. We were afterwards informed that the patient recovered completely.

CASE II.—S. M., woman, aged fifty years, admitted to the clinic December 22, 1930, with complaints of acute attacks in the right trigeminus region.

The patient first felt slight pains in the second trigeminus branch region eight years ago.

The neuralgia was found accompanied by a tooth illness and four teeth were extracted, but without any result. The pains kept on increasing. The internists assumed the pains were connected with a previous malaria and instituted a quinine treatment but without any result. The patient then consulted a surgeon, who removed the lower orbit branch of the right cheek. The pains kept on, whereupon the patient was treated by some pricks in the lip region, and that being without result, she was admitted to a nervous clinic and there treated by physical means. But no improvement took place. She was then admitted to the first surgical clinic with the diagnosis of Gasserian ganglion neuralgia.

The examination showed acute pain on all points of the right trigeminus.

December 26. An injection of 2 cc. alcohol absol. was made after the method of the writer into the Gasserian ganglion. The pains ceased. During the ten days of her stay in the clinic she was rid of her pains and left the clinic quite healthy. During one year and a half she felt no pains. They reappeared only in the beginning of July, 1932; she returned to the clinic July 27, 1933. Examination showed an idiopathic trigeminus neuralgia. Considerable spontaneous pains, intensified when touched. Nevertheless she affirmed that the pains were not so strong as before.

August 8. Injection of 2 cc. alcohol into the Gasserian ganglion. Decreasing of pains during ten days. She slept and ate normally. To stop the pains completely a second injection was made. During three weeks the pains stopped definitely.

CASE III.—W. E., peasant woman, aged thirty-seven years, was admitted to the clinic August 15, 1931, with complaints of strong attacks in the right trigeminus region. She had been suffering about four years. First onset in the lower jaw region, afterwards along the whole trigeminus region. She had been for a long time treated by therapeutic means, but without any result. The latter part of the time the pain became so frequent that they deprived the patient of sleep. The attacks occurred every five to ten minutes and were of such an intensity that the patient was ready to commit suicide.

The treatment with physiotherapeutic means had failed and the patient was admitted to the clinic. By mouth and otologist examination there were no organic alterations found connected with the trigeminus nerve.

August 18. A 2 cc. alcohol injection was made. The pains stopped in great measure the same day. As slight pains persisted in the mucosa of the cheek and lower jaw another alcohol injection was made. The pains stopped definitely and the patient left the clinic in a healthy state.

CASE IV.—A. P., a peasant, aged sixty years, was admitted to the hospital April 5, 1932, with complaints of severe periodical pains in the region above the right brow, skin, mucosa of the cheek and both jaws on the right side. Had been suffering during seven years; at first the attacks were not severe and were infrequent, later they became so frequent as fifty attacks daily at the time of entering the clinic.



## ALCOHOL INFECTIONS OF GASSERIAN FUNCTION

April 13. A 2 cc. of 96° alcohol injection into the Gasserian ganglion decreased but did not entirely stop the pains. However, the patient who before could not sleep without narcotics was able to do so now, except once in a while when slight pains would appear along the nerve. Afterwards the pains diminished little by little and the patient being unable to stay in the clinic because of agricultural labor was discharged considerably improved.

CASE V.—I. Z., aged seventy-seven, a labor invalid, was admitted to the clinic December 31, 1932, with complaints of almost permanent attacks of pain in the right face and head region along the trigeminus.

The first onset, which occurred spontaneously, was localized in the right forehead region and reiterated each four to five months. In 1929 the pains exacerbated, reiterated each two to three months, each time of ten to fifteen days' duration. Afterwards the pains appeared still more often, were accompanied by lacrymation and sometimes hindered the reception of food. After a pneumonia an attack occurred which lasted a month and was treated by galvanization. After a short time of relief a terrible attack occurred in the autumn of 1932, which made him incapable of sleeping and eating. The slightest touch on the skin of the right face caused unendurable pain. Treatment was without result, nor did he secure any relief by narcotics. The patient wasted, severe pains reiterated each five minutes. Peculiar tenderness was caused by pressure upon the trigeminus nerve trunks at their emergence from the osseous canals.

January 1. Injection of 2 cc. alcohol absol. into the Gasserian ganglion after the writer's method. The injection caused severe pain along the trigeminus. The same day the pains stopped, the patient was taking food and was sleeping without any narcotics.

January 10. The patient was feeling well, the pains almost ceased. A disagreeable sensation remained, however, in the mouth region and a second injection into the ganglion was made January 11.

January 14. The patient left the clinic almost quite healthy and the information afterwards confirmed the well feeling of the old man who became able to sleep and to eat.

CASE VI.—R. A., work-woman, aged twenty-four years, admitted to the clinic September 1, 1932, with complaint of recurrent pains along the right trigeminus. First onset eight months previously. At that time the patient asserts she had suffered from an influenza which was followed by pains in the upper and lower jaw, sometimes accompanied by vomiting. An inflammation of the Highmore cavity was supposed to be present and a cleaning of the latter was made in an ear clinic, but without any result. The pains increased and spread upon the upper brow region. When the patient was admitted to our clinic, examination manifested no organic alterations. The pains lasted, however, both at night and while at meals and became very frequent.

September 8 an alcohol injection into the Gasserian ganglion relieved the pains which became less acute. During the last decade of September the pains recurred and a 2 cc. reinjection was made. Thereafter the pains abated immediately. In beginning of October there was a new attack of pain in the right jaw and eye region.

October 5 a third alcohol injection was made, whereupon the pains decreased. After a fourth injection, October 20, the patient left the clinic considerably improved. After the injection the patient felt well for five months, when the pains recurred. She then applied to a health resort for treatment by physical means. While staying there her right eye sight deteriorated progressively, exophthalmus developed. In May, 1932, she was admitted to the nerve clinic of the Medical Institute of White Russia where after a six weeks' circumstantial examination a tentative diagnosis was made of a tumor in the middle skull fosse, pressing on the Gasserian ganglion, and a right optic atrophy.

June 10, 1932, she was admitted to the surgical clinic in a serious state. Not being able to walk, the patient was conveyed in a stretcher. She was exhausted, with a papular eruption on the whole body. The pains made her cry and scream; they were little influenced by narcotics. A 400 cc. blood transfusion was made and the next day operation (Irger) under ether narcosis was done. A large flap incision was made in

the right temporal region, with the base downwards, from 1 cc. before the lobe of the ear to the external angle of eye. The skin muscle flap was thrown down at the same time arcus zygomatic process was cut away.

In the temporal bone an opening trepaned 5 to 8 cc. in diameter. The arteria mening. media was ligated at the origin and cut; the base of the brain raised a little, and the Gasserian ganglion examined. There were no alterations manifest, nor any tumor seen. The palpation through the dura mater revealed more thickness of the base of the brain than that one of the external face. The dura mater was cut in the region of the temporal brain convolutions. This revealed no signs of alteration. However, the brain, raised a little upwards, revealed a tumor on the antero-interior pole of the lower temporal convolution, red colored and of thick consistence. The tumor was directed inwards the brain and to the upper orbital fissure, as if the tumor mounted the Gasserian ganglion—a condition which explained the severe trigeminus neuralgia. The tumor was removed, the dura mater was sewn up, the osseous defect was closed with aid of the temporal fascia and muscle. Skin sutures. The operation was finished happily. After the operation all pains disappeared. The histological examination revealed a gliosarcoma. A month after the operation the woman left the clinic in a good condition.

The sight was not regained. The woman, when last interviewed in April, 1933, was found to be free of pains, of relapse and in an excellent condition.

In our cases there were neither complications involving the vessels nor the nerves.

It may be noticed that after penetrating into the Gasserian ganglion the needle, in order to avoid the wounding of vessels, must be joined with an empty syringe and the piston drawn up. When a vessel is wounded blood will be seen in the syringe and it is then better to postpone the injection to another time. We have once observed such a case; the injection was postponed until the next day. In using the method of Härtel a series of complications may happen. Inflammations of the cornea were observed. Härtel himself described two cases of paralysis of the face nerve, once in using his own method and another time in using that of Harris. The whole materiel of Härtel are 173 cases during twenty years. Härtel noticed four times a transitory hæmorrhage of the soft tissues, other writers described woundings of the internal carotid. Tonne reports 2 cases of hæmorrhage in the region of the internal upper jaw artery, Härtel noticed a transitory paresis of the abducens nerve in 18 of his 173 cases. Wounding of large vessels (internal carotid, abducens and other nerves) has been noticed by other writers in using the methods of Härtel and Harris. In using my method the needle is being directed externally to the above organs.

A very serious question is that of relapses. These are to be explained either through a missed injection into the Gasserian ganglion, or if the trigeminus neuralgia is an accessory symptom of the cardinal disease.

One cannot disagree with Härtel in his assertion that if an alcohol injection, repeated three times, is not followed by a positive effect, not an idiopathic but a secondary neuralgia is to be supposed. In the last of our 4 cases a relapse set in despite 4 alcohol injections. Then a brain tumor was manifested.

Out of 173 cases of Härtel a relapse was noticed in 40, that will say in a 23 percentage. To obtain a complete effect the injections were to be made once, twice and three times.

## ALCOHOL INFECTIONS OF GASSERIAN FUNCTION

Peiper noticed 10 relapses on 12 cases of alcohol injection. Such a relapse frequency is after Härtel to explain by a defective technic.

Hoppe from the clinics of Bier reports about 125 injections into the Gasserian ganglion after the method of Härtel. Out of 33 cases, which had been reexamined, 15 were quite healthy. Gutnikow noticed 27 cases of recovery out of 35, in 18 of which the alcohol injection had been made once and in 9 of them repeatedly. The same author notices 2 cases of death in consequence of bleeding in the brain out of 54 injections.

Nevertheless, despite a considerable mortality, many surgeons continue to extirpate the Gasserian ganglion in cases of trigeminus neuralgia. The extirpation of the former is, according to Krause, followed by 11 per cent. of mortality, after Payer by 2-16 per cent.

The reason for that should be the development of adhesions after alcohol injections hindering the later extirpation of the Gasserian ganglion. It is difficult to say whether the alcoholization involves adhesions. Härtel denies it, nor could Kuhlenskampf find any adhesions after an alcohol injection made after the method of Härtel. Nor could we find any adhesions while operating on our last patient, who had had four injections into the Gasserian ganglion.

On the other hand, it is known that the extirpation of the Gasserian ganglion does not warrant from relapses, which reach 4-5 per cent. after Payer and still more after other writers. Many authors (Frazier, Adson), disappointed by the extirpation of the Gasserian ganglion, recommend the intersecting of the sensory radicles behind the ganglion—an operation which does not warrant from relapses. Thus, Kartavova recently demonstrated at the Pirogoff society in Leningrad a woman patient who was suffering from a trigeminus neuralgia. The patient had undergone an operation of dividing the third trigeminus branch and extirpation of the ganglion but without any result. The acute pains disappeared only after the  $C_1$ - $C_5$  ramicotomia. Härtel reports a case with persisting pains despite the ganglion extirpation, which the writer explains by the regeneration of the nervous tissue. The alcoholization only brought recovery.

Beyond any doubt improvement of the technic will extend the indications for the alcoholization of the Gasserian ganglion and its branches. In order not to discredit the method of the ganglion alcoholization it is necessary that every surgeon should thoroughly study the technic of the procedure. The indications for the extirpation will then be considerably restricted.

All the above-mentioned considerations force us to the conclusion that the method of Härtel has many serious demerits. The principal of them are: the impossibility to find beforehand the distance from the stitchpoint to the oval foramen, the lack of the direct path to the Gasserian ganglion and the danger of damaging major vessels and nerves.

On the other hand my method makes it possible to definitely find beforehand the distance, excludes the damaging of nerves, and minimizes the peril of damaging the minor vessels. It is not difficult to find the direction towards the oval foramen and the Gasserian ganglion.

## CONGENITAL FISTULÆ OF THE BODY OF THE TONGUE \*

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CONGENITAL fistulæ of the tongue in man occurring at the level of the foramen cæcum in connection with developmental abnormalities of the thyroglossal duct are, relatively speaking, not uncommon. As is well known they may be found in the median line between the base and the body of the tongue extending along the course of "descent" into the neck of the "median" thyroid anlage.

Fistulæ of the body of the tongue, on the other hand, apparently have been seen only very rarely. In the course of a careful examination of the literature the reports of only two such cases were discovered.

In the first of these<sup>1</sup> a centrally located longitudinal fistula, one-eighth of an inch in diameter, ran forward through the median raphe of the tongue from the level of the foramen cæcum to a point near the tip of the tongue. Here it ended in a fibrous nodule about the size of a hazelnut which "projected slightly from the under surface of the tongue about half-way between the tip of the tongue and the floor of the mouth." The fistula was a blind tract with the stoma opening posteriorly in the region of the tip of the lingual V. There was no persistent thyroglossal duct. The fistula had never produced any recognizable symptoms and was discovered accidentally during an operation for the removal of the fibrous nodule. It was excised easily by means of a longitudinal splitting of the dorsum of the tongue.

The second case,<sup>2</sup> Case I, presented a median transverse fistula which opened on the dorsum of the tongue at about the level of the juncture of the anterior and medial thirds of the body through the substance of which it plunged to end blindly in a median sublingual cyst. The patient was a female Italian, twenty-one years of age, who when she was eight years old, had noticed a swelling in the mouth beneath the tongue, which pushed the viscus upward into the buccal cavity. It increased in size so much that she was unable to swallow or to talk. The mass ruptured spontaneously in the floor of the mouth and discharged what was described as thick pus. Thereafter the patient remained well until she was about nineteen years of age when the swelling again appeared and elevated the tongue. The lesion was incised repeatedly via the buccal route and in each instance recurred. Finally it was approached by an incision through the right submaxillary region and a tube was passed into the cyst and left in place for six months. The wound was irrigated through this tube with a boric acid solution and during the process the patient noticed that the solution entered her mouth. Methylene blue injected into the neck would appear "on the surface of the tongue." When the tube finally was removed the neck wound healed, but thereafter the lesion occasionally discharged either from a reopening of the neck wound or from the surface of the tongue. Previous to these observations the fistulous opening on the dorsum of the tongue apparently had remained undiscovered. When seen by Colp there was no scar tissue evident in the floor of the mouth but in the median line of the dorsum of the "anterior third" of the tongue a small sinus was found which admitted a probe. The probe passed downward and

\*A portion of this work was conducted under a grant from the Douglas Smith Foundation for Medical Research of the University of Chicago.

## CONGENITAL FISTULÆ OF BODY OF TONGUE

anteriorly for a distance of about two inches. Pressure upon the region about the submental scar caused the discharge of brownish curdy material from the lingual fistula. At operation, via the submental route, a cyst the size of a pea was found just behind the symphysis of the mandible between the tongue and mylohyoid muscle. It was connected with the lingual fistula by a patent fibrous tract and contained an occasional hair. The lesion was excised quite easily.

Recently we have seen a case similar to the latter. Because of the unusual nature of these lesions and of their bearing upon the development of the tongue, it was felt that our case should be reported and should be considered in connection with the cases referred to above, in the light of the present knowledge of the development of the body of the tongue.

**AUTHOR'S CASE.**—The patient (C. L.) was a white male, twenty-one years of age, who entered the Surgical Clinic of the University of Chicago August 22, 1930, complaining of a small "growth" on the dorsum of the tongue which occasionally opened and discharged a thin "pus." The lesion had been discovered about one year before, previous to which time the patient had not been conscious of an abnormality of the tongue. It had not increased in size, had never become swollen, tender nor painful and at no time had interfered with the movements of the organ. Since its discovery, the lesion had "broken open and discharged" at intervals of four to eight weeks. As a rule the period of drainage lasted only a few days. The amount was never large, being only a few drops at a time. The discharge was always thin and whitish



FIG. 1.—Retouched photograph of lesion *in situ*. Lesion appears to lie farther posteriorly than actually was the case. Tip of papilla points to the left. Stoma of fistula lies just above white spot.

and was not offensive to taste or to smell. The patient had never observed a swelling beneath the tongue preceding the periods of discharge. He sought the clinic solely to determine the nature of the process because he feared it might be malignant.

The family history was essentially negative. His father, mother, a brother and a sister were living and well and without any known physical defects. No similar lesion or other form of developmental defect was known to have been present in any other member of his family by either the patient or his mother.

Aside from some of the common diseases of childhood, the patient had been perfectly well. The Wassermann and Kahn tests and urine were negative. Hemoglobin, 85 per cent., red blood cells, 4,360,000; white blood cells, 10,450.

The patient was a slender, but otherwise rather well-developed and nourished young male in good health. A careful physical examination failed to reveal any developmental defect or abnormality other than that of the tongue. The neck was normal in contour



M. LAURENCE MONTGOMERY

and free from any recognizable defect. To palpation the thyroid gland appeared normal in size and in location. The chest, heart, lungs, abdomen, extremities and reflexes appeared to be normal. Examination of the nasal passages revealed nothing unusual. The arch of the hard palate seemed a little high, but there were no defects. After cocainizing the posterior third, or base, of the tongue and the region of the foramen cæcum a careful examination of these structures was made by digital palpation and with the aid of a laryngeal mirror and a probe. The base of the tongue was entirely normal. No depression was found at the site of the foramen cæcum, and there was no connection between this region and the lesion in the anterior part of the tongue. Except for the fistulous opening, the body of the tongue appeared to be quite normal.

*Lesion.*—On the dorsum of the body of the tongue, in the median sulcus, a little posterior to the junction of the anterior and middle thirds of the viscus, there was a small papillary projection four to five millimetres high with a broad but slightly constricted base, about three millimetres in diameter. Its apex pointed somewhat to the left and anteriorly. (Fig. 1.) The lesion was not reddened, swollen, tender or painful.



FIG. 2.

FIG. 3.

FIG. 2.—X-ray, Lateral view. Shows probe passing through fistula into cyst filled with iodized oil. Horizontal black line crossing probe marks dorsum of tongue.

FIG. 3.—X-ray, Anteroposterior view. Shows cyst lying in median plane.

It had the appearance of a congenital process. On the anterior surface of the papule, near its apex, there was a minute opening about one millimetre in diameter through which a small probe was passed with some difficulty because of the presence of an annular constriction immediately beneath the mucosa. Beyond this point the probe moved easily, straight through the dorsoventral thickness of the tongue and turned in a broad curve forward toward the symphysis of the mandible. In this position the tip of the probe barely could be felt in the median line, deeply beneath the skin of the submental area, about one and one-half centimetres from the symphysis. It appeared to lie on the buccal surface of the mylohyoid muscle. No sinus could be found leading from the fistula toward the foramen cæcum. During the examination a few drops of a cloudy watery fluid containing whitish flakes exuded from the opening. The sinus tract was then injected with iodized oil. It would admit only one cubic centimetre of the fluid. Anteroposterior and lateral X-rays were taken. They showed a small, irregular, blind pouch lying in the median line beneath the tongue, apparently above the mylohyoid muscle and between the genioglossus muscles. (Figs. 2 and 3.) Since the lesion was giving no trouble it was not disturbed.

## CONGENITAL FISTULÆ OF BODY OF TONGUE

DISCUSSION.—This group of cases is too small to be used for generalizations referable to the symptomatology and treatment of congenital fistulæ of the body of the tongue. Nevertheless, it seems apparent that the former will depend upon the size and location of the lesion and associated cysts, when they are present, and may be obstructive in nature, with symptoms of inflammation superimposed if infection is present, whereas the latter will be subject to the principles which have been determined for the treatment of congenital cysts and fistulæ located elsewhere in the body. These are, as is well known, that in the absence of symptoms one should leave the lesion alone; that if interference becomes necessary complete excision is imperative if recurrence is to be prevented; and that incision, except in the presence of certain forms of inflammation, is contra-indicated.

It is not our purpose at this time, however, to stress symptomatology and treatment but rather to consider the possible modes of origin of transverse and longitudinal fistulæ of the body of the tongue.

Previous to 1901 it was rather generally believed that the body of the tongue arose from a single, median anlage. As long as this belief was held there was difficulty in visualizing a mechanism which would explain the occurrence of certain well-recognized developmental anomalies of this organ. In 1901, however, Kallius<sup>3</sup> and Hammar,<sup>4</sup> working independently, established the fact that the body of the tongue arises as a paired organ, whereupon it became evident that the plane of fusion between the anlagen of this organ reasonably might account for the appearance of such anomalies just as similar planes of fusion in other parts of the head and neck are responsible for comparable lesions. Keith<sup>5</sup> presented this conception clearly when he stated, "the bilateral origin of the tongue explains the occasional occurrence of a bifid tip and the formation of cysts in the median raphe." He did not discuss the possible origin of fistulæ of the body of the tongue, which is not surprising since Furnivall's case was the only one which had been recorded up to that time and it was believed to have arisen from the thyroglossal duct. (Bland-Sutton.<sup>6</sup>) Finally Kallius,<sup>7</sup> in 1910, published an extension of his original studies upon the development of the tongue in which he showed, in the pig, that the body of this organ arises from one median and two lateral anlagen. According to this author the median anlage is a derivative of the tuberculum impar which in the fully formed tongue is responsible for a wedge-shaped portion, whose base corresponds with

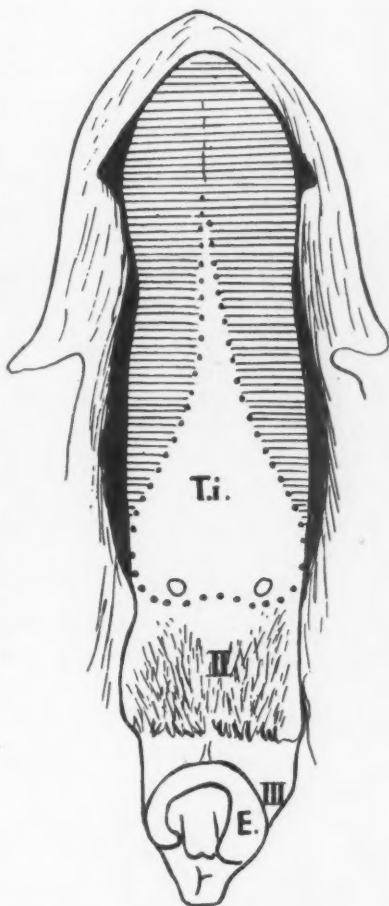


FIG. 4.—Shaded areas mark portion of body of tongue arising from lateral anlagen. T.i.—Tuberculum impar derivative. II.—Posterior third (base) of tongue. (After Kallius, 1910.)

the sulcus terminalis and whose apex reaches anteriorly to a point in the median raphe at about the juncture of the anterior and medial thirds of the body. (Fig. 4.) The lateral anlagen which arise on either side of the median anlage, and which are derivatives of the first branchial arches, complete the formation of the tongue by supplying the lateral portions of the posterior two-thirds of the body and the entire substance of the anterior one-third. As is seen from the figure, the fusion planes between these anlagen form a Y, the stem of which corresponds with the line of fusion between the lateral anlagen, and the arms of which are the diagonal lines of fusion between the tuberculum impar derivative and the lateral anlagen.

It is apparent from this that these fusion planes are comparable with those which characterize the development of the other branchiogenic derivatives in the neck and that from analogy the fusion planes in the tongue may be expected to give rise to cystic and fistulous anomalies similar to those which have their origin in the other branchiogenic fusion planes. If this reasoning is correct, one would expect to find fistulae of the body of the tongue occurring at any point along the Y of the fusion planes. Such may be the case, but the literature is singularly devoid of such case records.

If we consider first the two cases of transverse fistulae it will be observed that they both occurred in approximately the same location and that this position corresponds closely with that of the tip of the tuberculum impar derivative in the fully developed tongue. (Fig. 4.) Although it is recognized that two cases are too few to be used as the basis for any final conclusions, it seems possible that there may be a causal rather than a coincidental relationship between these two observations. We wish, therefore, to present the hypothesis that the median, transverse fistulae of the body of the tongue seen in the cases reported by Colp and ourselves arose through the mechanism of incomplete fusion of the three anlagen of the tongue at the mutual line of juncture at the tip of the tuberculum impar derivative. Moreover, we suggest that it may be possible that this line is more susceptible to the formation of fistulae than any other point along the fusion planes of the body of the tongue, because of fusion stresses which are perhaps greater when three elements are involved.

The occurrence of a sublingual sac in connection with these fistulae suggests that there has been a prolongation of the defective process into the sublingual tissues, portions of which arise in all probability from the anlagen which give origin to the overlying division of the body of the tongue.

Since this hypothesis of the origin of transverse lingual fistulae and associated sublingual cysts or sacs is based upon the assumption that the tuberculum impar plays the important part in the formation of the tongue which has been attributed to it by Kallius it becomes immediately evident, from the nature of the fistula discovered by Furnivall, that the hypothesis which has been presented is in error or that some other factors may have been at work in the latter instance.

We prefer to accept the work of Kallius and to believe that the latter is the case. Although it is recognized that at this time positive proof cannot be brought to bear upon this belief, it should be stated that if for any reason

## CONGENITAL FISTULÆ OF BODY OF TONGUE

the tuberculum impar derivative failed to develop properly a median longitudinal defective fusion process might result. It is possible that the fibrous nodule which Furnivall found was a vestigial tuberculum impar derivative which either migrated forward with or was passively carried forward by the developing lateral anlagen and that as a result of either the deficient development or the forward movement of this anlage factors were put into play which permitted the appearance and persistence of the median longitudinal fistula. We cannot accept the hypothesis of Bland-Sutton that this fistula is a forward prolongation of the thyroglossal duct since in determining the etiology of such lesions the most conveniently available factors should reasonably be suspected first, and fusion planes in the development of the body of the tongue are sufficient in themselves. Furthermore, except for this case, there is no certain evidence that prolongations of the thyroglossal duct extend forward into the body of the tongue from the region of the foramen cæcum.

It is our belief, then, that both the longitudinal lingual fistula of Furnivall and the transverse lingual fistulæ reported by Colp and ourselves arose as deviations from the normal development of the body of the tongue as described by Kallius and are explainable upon that basis.

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## VENOUS OBSTRUCTION IN THE UPPER MEDIASTINUM

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OBSTRUCTION of the superior vena cava or innominate veins associated with lesions in or adjacent to the upper mediastinum has often been noted. Eyster and others have called attention to an elevated pressure of the upper venous system in the presence of mediastinal fibrosis or tumor and in cases of advanced fibroid pulmonary tuberculosis.<sup>1</sup> A complete bibliography and a report of studies in two cases of superior vena cava obstruction has been recently given by Ehrlich, Ballou and Graham.<sup>2</sup>

We have recently had the opportunity to measure the venous pressure in a large series of surgical patients with lesions in the upper chest or mediastinum. In fifty of these patients the presence of venous obstruction was suggested by an abnormally high venous pressure as measured in the brachial vein. In all the cases a point of probable mechanical obstruction in the upper mediastinum could be demonstrated. In the cases where an operation which relieved the obstruction was possible the symptoms and signs of obstruction promptly disappeared and the venous pressure returned to normal. Upon analyzing the symptoms of these patients, it was found that they could be divided into two main groups. Many symptoms and signs were due, of course, to the lesion which caused the obstruction. Other symptoms were attributable to the disturbed upper venous circulation.

It is the purpose of this presentation to consider the problem of mediastinal venous obstruction as encountered in the type of surgical patient included in this series. An attempt has been made to differentiate the symptoms due to the venous obstruction and those due to the lesion causing the obstruction. Emphasis is placed upon recognition of the condition when the upper venous system is not obviously engorged. Measures which provide relief of the condition are discussed.

*Symptomatology.*—The important symptoms and signs encountered in this group of patients showing elevated venous pressures resulting from mediastinal lesions are summarized in Table I. In this table the probable factor responsible for the symptom or sign is oppositely listed. Dilatation of the neck and arm veins is, of course, the most recognizable sign. However, in some cases, especially in obese individuals, the dilatation of these veins may not be manifest. In the more marked degrees of obstruction the large veins become dilated greatly and the small veins over the anterior chest-wall become enlarged to form an easily visible collateral circulation with the internal mammary vessels and thence through the abdominal veins into the

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## VENOUS OBSTRUCTION IN UPPER MEDIASTINUM

TABLE I

### *Symptoms and Clinical Signs of Mediastinal Venous Block*

Symptoms	Cause
1. Dilated veins	1. Increased venous pressure
2. Cerebral symptoms	2. Dilated cerebral veins with increased intracranial pressure and chronic congestion of cerebral tissues
(a) Headache	
(b) Fullness in ears	
(c) Tightness in head	
(d) Dizziness	
(e) Mental lethargy	
3. Cardiac symptoms	3. (a) Obstruction of venous return
	(b) Increased load on heart from obstruction to circulation
4. Cyanosis and flushing of skin	4. Decreased oxygenation of tissues caused by venous congestion
5. Pain over course of large veins	5. Stretching of vein walls and pressure on surrounding tissues
6. Skin changes	6. Disturbed protein and fluid nutrition of tissues
(a) Dryness	
(b) Dermatoses	
(c) Edema	

lower venous system and the inferior vena cava. Figs. 1, 2 and 3 illustrate dilated veins and a well-developed collateral circulation which have resulted from upper mediastinal lesions. The dilatation of the peripheral veins with

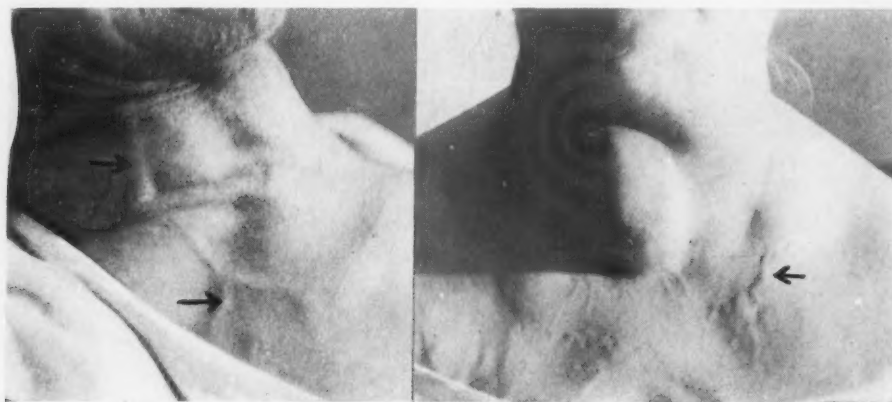


FIG. 1.

FIG. 2.

FIG. 1.—Dilatation of the large neck veins from mediastinal obstruction.

FIG. 2.—Dilated superficial neck veins carrying collateral circulation in obstruction of both innominate veins.

stretching of the vein wall and pressure on surrounding tissues commonly causes pain over the course of the larger venous trunk in neck and arm. Such pain was a frequent symptom with the patients in this group. Cyanosis of head and arms and flushing of the face was frequently observed. These changes may be very slight most of the time, but are typically increased by slight exertion or by lowering the head or arm a short distance.

In cases where compression of the trachea is present in addition to obstruction of the vein, the question is frequently raised as to whether the cyanosis is caused by inadequate oxygen intake through the trachea or by the effect of the venous obstruction. If the cyanosis is due to tracheal obstruction, it will be generalized. If it is due to mediastinal venous obstruction, it will be localized to the head and arms. Lowering or raising the head more readily alters the degree of cyanosis when it is due to venous obstruction, although it may also affect the degree of tracheal obstruction.

Symptoms such as headache, dizziness, tightness in the head, fullness in the ears, mental lethargy, pain in the region of the jugular foramen, and so forth, were noted in many of the cases. Such symptoms are attributable to

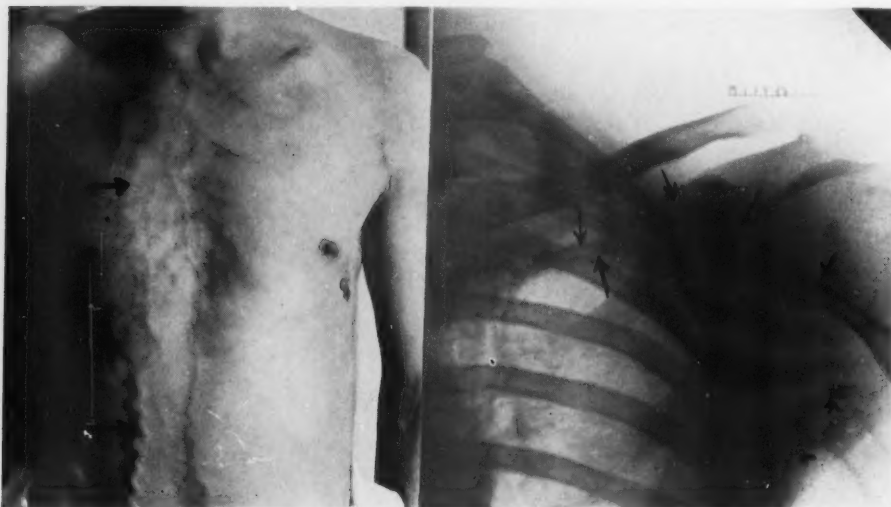


FIG. 3.

FIG. 4.

FIG. 3.—Greatly dilated abdominal veins carrying collateral circulation from neck and arm veins through the internal mammary vessels to the inferior vena cava in case of mediastinal fibrosis.

FIG. 4.—X-ray of veins (phlebogram) after injection of neo-skiodan in the left brachial vein. (Case No. 36751.) The arm veins are greatly dilated with fusiform dilatations at each valve, caused by the back-pressure against the valve. In the axilla, as the arm veins reach the chest-wall the injected dye can be seen to suddenly shoot off at right angles into the narrow veins of the chest-wall which form the collateral circulation. Photograph of this collateral circulation is shown in Fig. 3 above.

the effect of dilatation of the cerebral veins. Because these cerebral symptoms are vague and usually insidious in onset, they are apt to be overlooked and even when marked may be attributed to general debility, arteriosclerosis or some other more familiar condition.

In severe long-standing cases, cardiac symptoms, particularly dyspnea on exertion, were occasionally noted. Skin changes such as dryness and edema occurred not infrequently. Dermatoses of the type seen commonly with varicose veins of the lower extremity were seen infrequently in this group.

The typical symptomatology of a case of venous obstruction of the upper mediastinum is well illustrated by the case of Mr. O., No. 36751. This patient's admission complaint was of blood rushing to the head, particularly when he bent over. His neck was enlarged so that his collars did not fit. He had noticed swelling of the veins on his chest and arms. He also reported that his face was slightly swollen in the morning, and was more flushed

## VENOUS OBSTRUCTION IN UPPER MEDIASTINUM

than it used to be. He had a feeling of heaviness and tightness of the upper chest, neck and head, and complained of marked dyspnoea on exertion. In addition he had pains in the region of the right jugular foramen radiating down the neck into the shoulder and upper chest. Physical examination showed marked dilatation of the arm and neck veins, with visible collateral circulation extending through the internal mammary veins (to the abdominal veins) (Fig. 3). There was cyanosis of the face and hands which was increased by bending or by exertion. There was obviously a marked bilateral obstruction of the upper venous system. The presence of this obstruction was confirmed by venous-pressure measurements, which were plus forty centimetres (normal six to ten centimetres) and by phlebogram with intravenous neo-skiodan, which demonstrated obstruction beginning at the apex of the mediastinum with a well-outlined collateral circulation. (Fig. 4.) X-ray showed no evidence of tumor of the mediastinum, and biopsy of two lymph-nodes, one in the neck and one in the axilla, showed normal lymphatic glands. A diagnosis was made of obstruction to the superior vena cava caused by fibrosis of the mediastinum. This case was particularly interesting because it showed clearly the effects of venous obstruction uncomplicated by the effects of tracheal obstruction, arteriosclerosis, cachexia or post-operative shock.

*Pathological Changes.*—The pathological changes associated with obstruction of the upper venous system are well known to physiologists, but have not received much clinical attention. The most serious change is the effect on the cerebral tissues. Dilatation and increased pressure of the cerebral veins occurs in every case of obstruction of the upper venous system. It is well known that an increased pressure in the cerebral veins is promptly reflected as an increased intracranial and cerebrospinal pressure (Quackenstedt test). This fact has also been confirmed by the experiments of Weed and Hughson<sup>3</sup>. It would seem that such increased pressure and dilatation of the cerebral vessels, even though slight, must have a harmful effect upon cerebral function when maintained for a prolonged period. It is certainly an adequate cause for symptoms such as headache and dizziness which were noted often. In some cases it is probable that there is even some degree of chronic passive congestion of the cerebral tissues similar to the chronic passive congestion of lungs or liver seen with the increased venous pressure in mitral or tricuspid stenosis.

In addition to its effect upon the cerebral vessels, chronic venous obstruction has an unfavorable effect upon the metabolism of the tissues in general. Earnstein and Volk<sup>4</sup> demonstrated a marked disturbance in the rate of CO<sub>2</sub> elimination and O<sub>2</sub> absorption of the tissues in the presence of venous congestion. This is evidenced by a decreased threshold for cyanosis in the parts affected by the obstruction, and is largely responsible for the cyanosis observed in these cases. The significance of the impairment to oxygen metabolism can easily be appreciated when it is realized that the oxygenation of the cerebral tissues, and particularly the vital centres in the medulla are affected, as well as the oxygenation of the skin and peripheral tissues. Krogh, Landis, and their associates<sup>5, 6</sup> studied the movement of fluid and protein through capillary walls in the presence of increased venous pressure. They found, under such circumstances, that the fluid and protein interchange was impaired with a resulting injury to the nutrition of the tissues. This disturb-

ance of tissue nutrition becomes manifest clinically by dryness of the skin and various types of dermatoses.

Venous obstruction also has a direct effect upon cardiac function. It is well recognized by cardio-physiologists that the efficiency of the heart is related to peripheral venous pressure. Also the cardiac output is directly dependent upon the venous return to the heart.<sup>7, 8</sup> The venous return is obviously unfavorably affected by an mechanical obstruction to the superior vena cava or the innominate veins. In order to keep the venous return normal in spite of the obstruction, the heart must transmit greater pressure to the peripheral circulation. The heart is thus affected in two ways: first, by obstruction of the venous return; and second, by the burden of maintaining an

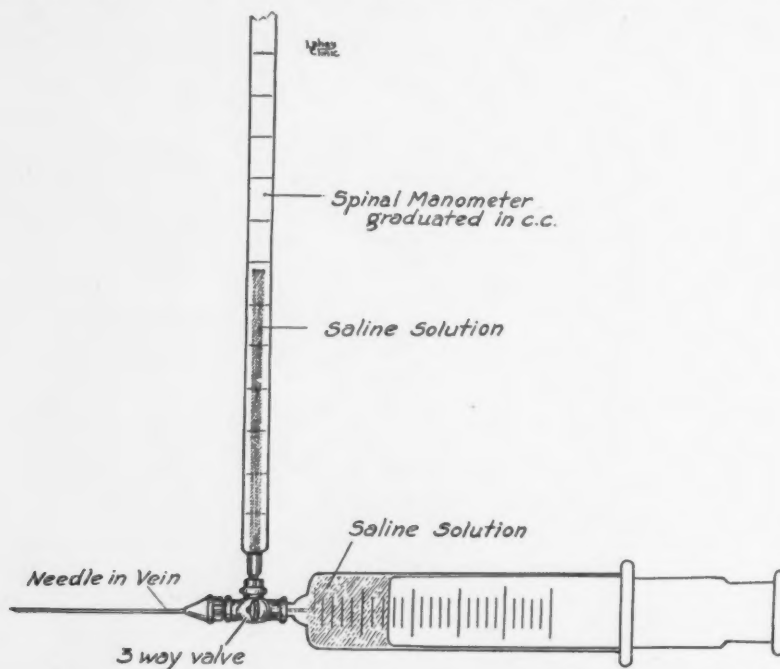


FIG. 5.—Apparatus used for measurement of venous pressure by the direct method. The level of fluid in the manometer gives the venous-pressure measurement in centimetres of water.

increased pressure in the peripheral vessels. The effect is probably slight in most cases but when prolonged over a period of years, may be sufficient to cause cardiac disability.

*Value of Venous-pressure Estimation.*—In the surgical treatment of cases of upper mediastinal venous obstruction it is first important to confirm the diagnosis by accurate venous-pressure measurement. All cases show an elevated venous pressure in the brachial vein, either bilateral or unilateral, caused by back-pressure from the point of obstruction. If the venous pressure is not elevated, mechanical venous obstruction may be definitely ruled out. In addition, the degree of elevation of the venous pressure gives the only true index of the degree of venous obstruction.

## VENOUS OBSTRUCTION IN UPPER MEDIASTINUM

It is important to use a standardized and uniform technic. The method of direct venous-pressure measurement credited to Moritz and Tabora<sup>9</sup> we have found most practical and reliable. The pressure is taken in the brachial vein. With the patient lying on his back the arm is placed on a pillow, so that the brachial vein is on a level with the right auricle. Since the venous pressure in the arm is so readily influenced by the effects of gravity, it is necessary to have the arm in the same position for all determinations. A needle is introduced into the vein. This needle, as shown in Fig. 5, is attached to a three-way valve which is connected with a small syringe containing normal saline or citrate solution, and is also connected to an upright glass manometer (water spinal manometer tube) or any tube calibrated in centimetres. After introduction of the needle into the vein a small amount of blood is drawn back into the syringe which contains the saline. The valve is turned, the saline pushed up into the manometer and the three-way valve is turned again to connect the manometer with the vein. The saline in the manometer falls to the level of the pressure in the vein as shown in centimetres on the tube. In order to be sure that the level reached is a true index of the vein pressure, part of the saline is then withdrawn from the manometer, and the manometer again connected with the vein, allowing the blood to push the remaining saline up until the level of the vein pressure is again reached. This gives a simple and satisfactory check of the accuracy of the method.

We have used this technic in some four hundred and fifty venous-pressure estimations. We have found the normal venous pressure to vary between six and ten centimetres of water pressure, with an average of eight centimetres. The cases of mediastinal venous obstruction recorded here gave pressures of fifteen centimetres or over, with recordings in a few cases as high as forty centimetres.

TABLE II  
*Causes of Venous Obstruction in 50 Cases of Mediastinal Venous Block*

Diagnosis	No. of Cases
Intrathoracic goitre . . . . .	15
Post-operative oedema of mediastinum . . . . .	2
Mediastinal lymphoblastoma . . . . .	3
Cellulitis of mediastinum . . . . .	1
Mediastinal fibrosis (pulmonary tuberculosis) . . . . .	10
Extramediastinal pressure	
(a) post-operative thoracoplasty . . . . .	14
(b) post-operative phrenicectomy . . . . .	2
(c) After pneumothorax . . . . .	1
(d) Hydropneumothorax . . . . .	1
(e) Carcinoma of lung . . . . .	1

*Treatment.*—With the fact of venous obstruction established, treatment depends upon the nature of the causative lesion. The causes of the venous obstruction in the fifty cases here reported are given in Table II. The point of obstruction was usually in one or both innominate veins, occasionally in



the superior vena cava. The principal ways in which these various lesions produced obstruction of the veins are illustrated in Fig. 6. These are, briefly: (1) pressure on the veins (mediastinal tumor or inflammation); (2) constriction of the vein (fibrosis of the mediastinum); (3) distortion and narrowing of veins by extramediastinal pressure.

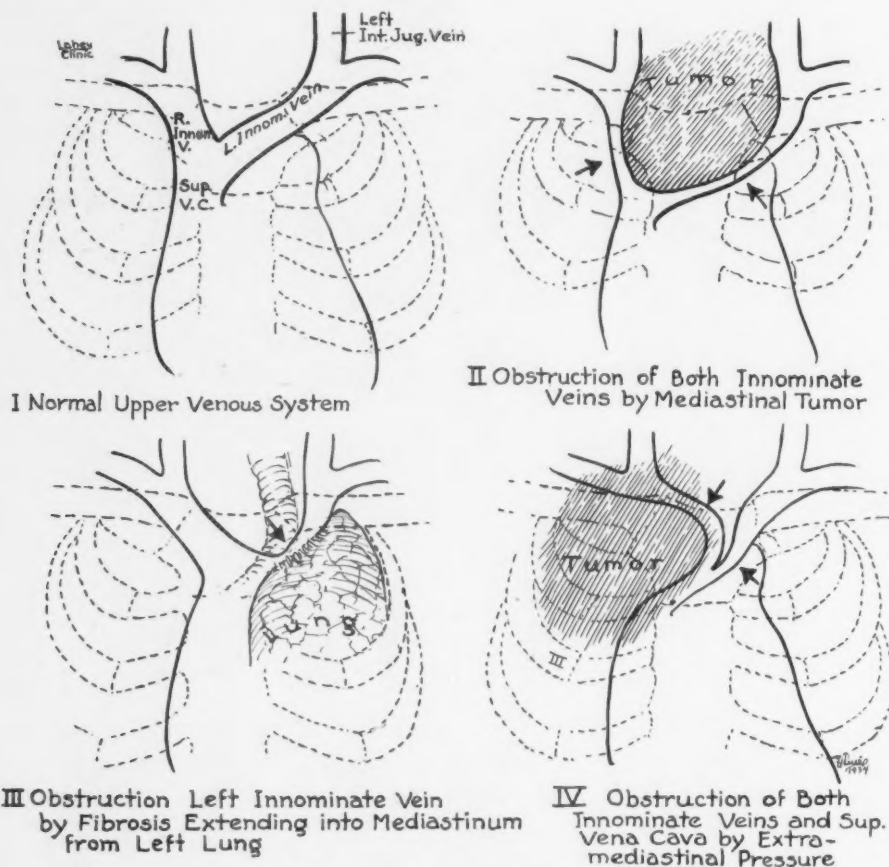


FIG. 6.—Diagrammatic representation of the principal mechanisms by which lesions of the upper mediastinum and chest may produce obstruction of the superior vena cava and innominate veins. (I) Shows schematically the normal position and size of the superior vena cava and tributary veins. (II) Shows the marked compression and distortion of these veins which may occur with a large mid-line mediastinal tumor such as a substernal goitre or mediastinal lymphoblastoma. (III) Illustrates the distortion and constriction of one of the innominate veins which may occur with extensive fibrosis in one lung with pull on the adjacent mediastinal structures. The deviation of the trachea is shown to illustrate how the entire mediastinum is involved. Elevation of venous pressure in these cases is usually unilateral. The venous pressure on the opposite side is normal since the vein on the opposite side is not involved. (IV) Illustrates the effect of extramediastinal pressure. The illustration shows a large tumor pressing against the mediastinal structures similar to the tumor shown in the X-ray of Fig. 14. The same effect on the mediastinal structures is caused by a collapse of the lung following upper thoracoplasty or by other causes of unilaterally increased pressure against one side of the mediastinum. Either one or both innominate veins may be compressed. In the case of carcinoma of the lung illustrated by the X-ray in Fig. 14 both innominate veins and the superior vena cava were compressed with elevation of the venous pressure in both arms. X-rays of cases in which these different forms of mechanism schematically shown here were closely approximated are shown in Figs. 8, 10, 12, 13 and 14.

There were fifteen cases of intrathoracic goitre which showed obstruction of the upper venous system. Twelve of these were operated upon successfully and the venous block relieved. Two of the remaining three cases had severe hyperthyroidism associated with large intrathoracic goitres and did

## VENOUS OBSTRUCTION IN UPPER MEDIASTINUM

not survive operation. The third case, showing only mild venous obstruction, was regarded as too poor a risk for operation because of serious heart disease.

The following three cases are representative of this intrathoracic goitre group. The occurrence of venous obstruction, post-operatively, as a result of œdema in the goitre wounds, is well illustrated by Case III.

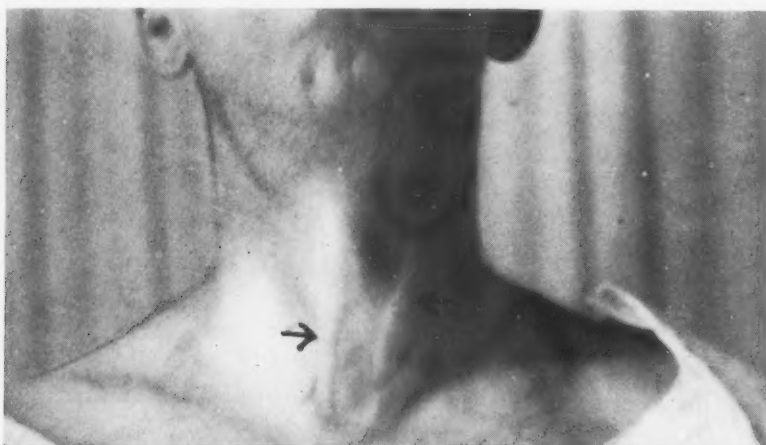


FIG. 7.—Photograph of neck veins in case of unilateral intrathoracic adenoma of thyroid. (No. 37601.) Note dilatation is confined to veins on one side of the neck indicating obstruction of one innominate vein. Goitre is not visible, being entirely intrathoracic.

CASE I.—Mr. S., No. 37601. This patient had a large adenoma of the right lobe of the thyroid the size of an orange, entirely intrathoracic. The veins of the right neck and arm were dilated whereas the veins of the left neck and arm were normal. (Fig. 7.) A roentgenogram revealed an intrathoracic goitre and marked tracheal deviation. The venous pressure was fifteen centimetres on the right and six on the left. A right subtotal hemithyroidectomy was done, entirely removing the intrathoracic adenoma. Seven days after

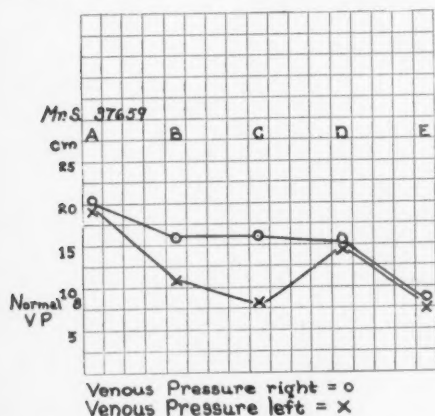


FIG. 9.—Graph of the level of venous-pressure measurements in patient No. 37659. (A) before operation; (B) twelve days after first operation (removal of left intrathoracic goitre); (C) six weeks after first operation and immediately before second operation; (D) twelve days after second operation (removal of right intrathoracic goitre). (Edema of the wound was present at this time; (E) one month after second operation.

operation the dilated veins of the right neck and arm had entirely disappeared, the venous pressure was within normal limits. The measurements in both the right and left arm were eight centimetres.

CASE II.—Mrs. B., No. 32760, had an adenomatous enlargement of the thyroid the size of a small grapefruit on each side. The right lobe was largely superficial but extended a short distance down into the mediastinum. The tumor on the left was almost entirely within the thoracic cavity, deviating the trachea to the right. (Fig. 8.) The neck and arm veins were dilated on both sides but particularly on the left. The venous pressure on the left was sixteen centimetres and on the right thirteen centimetres. A subtotal thyroidectomy was performed. One month later the dilated veins had entirely disappeared. The venous pressure in both arms was found to be eight centimetres.

PILCHER, 2D, AND OVERHOLT

CASE III.—Mr. S., No. 37659. This case is presented because of a bilateral venous obstruction due to a bilateral substernal goitre, operated upon in two stages with corresponding reductions in the venous obstruction following each operation. Each thyroid lobe was about nine centimetres in diameter and almost entirely intrathoracic on both sides. He also had hyperthyroidism but no evidence of cardiac decompensation. There was bilateral dilatation of the neck and arm veins. The venous pressure was equal on the two sides and measured twenty centimetres. The operative procedure was divided into

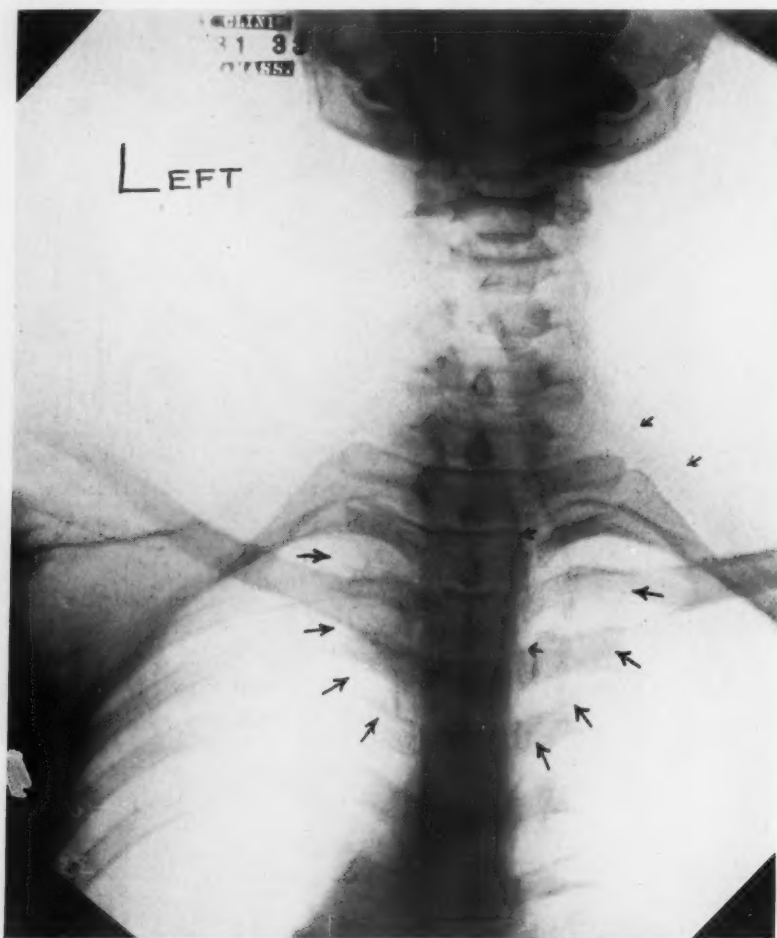


FIG. 8.—X-ray of large bilateral goitre deeply intrathoracic on left. (No. 32760.) Shadow of right goitre above clavicle and left goitre below clavicle causing obstruction chiefly of left innominate vein.

two stages, the left intrathoracic goiter being removed first. Twelve days after this operation the venous pressure on the left was eleven centimetres and on the right sixteen centimetres. The veins were still markedly dilated on the right but were almost normal on the left. Six weeks later the veins on the operated side were entirely normal and the venous pressure was eight centimetres. The pressure on the right, however, was still sixteen centimetres, and the veins were visibly dilated. The right intrathoracic goitre was then removed. Following this procedure there was a great deal of oedema of the wound and the veins became dilated on both sides of the neck and arms. Venous pressure readings ten days after operation were fifteen centimetres on each side. One

## VENOUS OBSTRUCTION IN UPPER MEDIASTINUM

month after operation when the œdema had subsided from the wound the dilatation of the veins had disappeared entirely. A graph of the level of the venous-pressure measurements in this patient is given in Fig. 9.

There were three cases of mediastinal lymphoblastoma with venous obstruction. All three of these cases were treated with intensive X-ray therapy. Follow-up studies were made in two patients. Both had responded well to the radiation and both showed a corresponding diminution in the venous obstruction.

CASE I.—Mr. B., No. 34740, was admitted with a complaint of tightness in the head, cyanosis and difficulty in breathing. The chest roentgenogram showed a large mediastinal tumor. (Fig. 10.) The veins in the neck and arms were moderately dilated. The venous pressure was forty centimetres, an extremely high figure. After a three-weeks' course of X-ray treatment, the mediastinal tumor almost entirely disappeared by X-ray. (Fig.

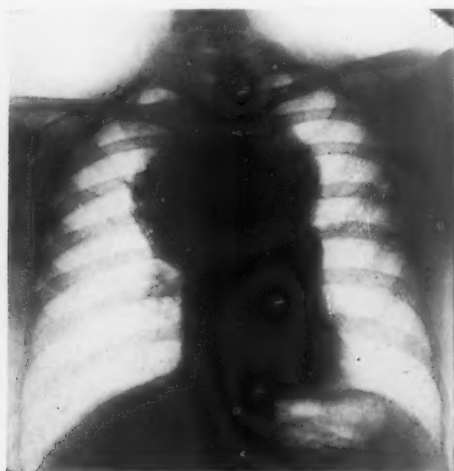


FIG. 10.

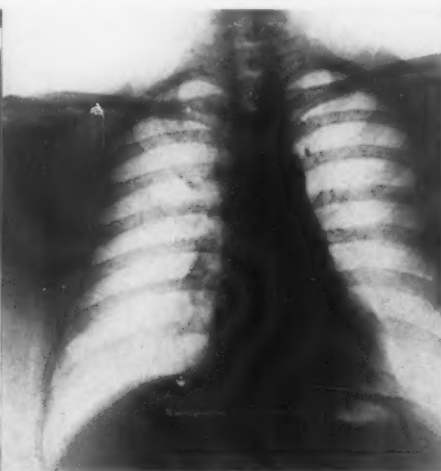


FIG. 11.

FIG. 10.—X-ray of tremendous lymphoblastoma of upper mediastinum with marked obstruction of superior vena cava. (No. 34740.)

FIG. 11.—X-ray of the same case (No. 34740) one month after radiation therapy showing the tumor almost entirely destroyed. Venous pressure had returned almost to normal at the time this X-ray was taken whereas, the venous pressure was markedly elevated at the time X-ray shown in Fig. 10 was taken.

11.) The symptoms had been entirely relieved. The tightness in the head had gone. Breathing was free. Cyanosis disappeared. The venous pressure was found to be twelve centimetres on each side. This patient is still under treatment. He has remained free of symptoms for a period of eight months. There has not been a return of a visible growth, and there are no evidences of venous obstruction.

CASE II.—Miss C., No. 37314. In this case symptoms similar to those present in Case I were reported. A mediastinal tumor was discovered by X-ray. Enlarged glands in the neck were also present. A biopsy of one of these glands showed the lesion to be a lymphoblastoma. After X-ray therapy the tumor disappeared almost entirely, and the dilatation of the veins subsided.

A patient with cellulitis of the mediastinum was studied. Facts of the case are interesting from the diagnostic point of view only as no satisfactory treatment could be given.

Mrs. B., No. 32588, was admitted with an acute upper respiratory infection and laryngitis. Cellulitis of the neck rapidly developed and then descended. The veins of the arms and neck became dilated, and cyanosis of the face, neck, and arms developed. Symptoms of respiratory obstruction were present. A diagnosis of cellulitis of the mediastinum was made. The venous pressure was found to be twenty-five centimetres in each arm. Course was progressively downhill and a positive blood culture was obtained shortly before death.

Eleven cases of venous obstruction associated with fibrosis of the upper mediastinum were studied. Ten of these cases of obstruction were associated with chronic fibroid pulmonary tuberculosis with involvement of the mediastinum. One case was associated with chronic lung abscess with marked fibrosis. In all, the chest roentgenogram showed a deviation of the mediastinum to the involved side. The mechanism by which venous obstruction was produced in these cases is shown in diagram III, Fig. 6. Fig. 12 shows the X-ray of a typical case of fibrotic pulmonary tuberculosis with deviation of the trachea and pressure on the upper mediastinum.

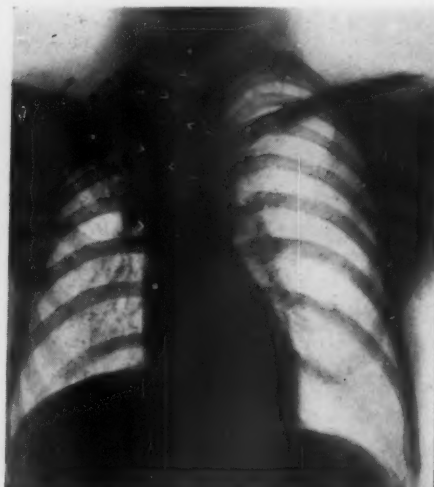


FIG. 12.

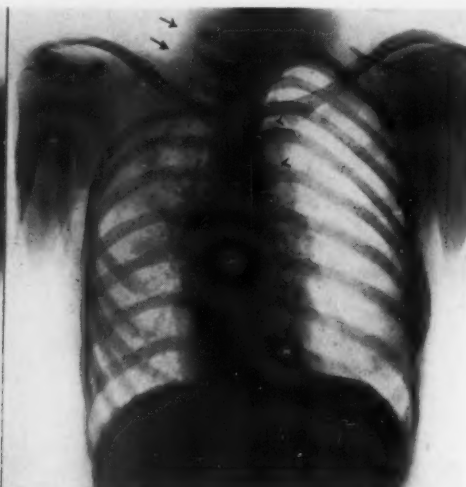


FIG. 13.

FIG. 12.—X-ray of case of fibrotic pulmonary tuberculosis with marked fibrotic pull on the mediastinum. The trachea and upper mediastinal tissues can be seen to be drawn sharply to the right towards the tuberculous lesion.

FIG. 13.—X-ray of chest following left upper thoracoplasty. The trachea and mediastinum are pushed over into the right chest by the pressure on the left upper lung.

All cases received surgical treatment (thoracoplasty) for their pulmonary disease. With relief of the fibrotic pull on the mediastinum, the venous obstruction in all were promptly relieved. It is interesting to note that in most of these patients the presence of venous obstruction could not be detected by clinical examination. Therefore, in this group the presence of a disturbed upper venous circulation was discovered solely by direct venous-pressure readings. The following cases are representative of this group.

CASE I.—Mr. C., No. 35353. The patient had pulmonary tuberculosis with multiple cavitation and extensive fibrosis of the left upper lobe. The trachea and the heart were displaced to the left. The venous pressure on the left was fifteen centimetres compared to eleven centimetres on the right. A left upper thoracoplasty was performed. After



## VENOUS OBSTRUCTION IN UPPER MEDIASTINUM

operation the heart and the mediastinal structures returned to their normal position. Venous-pressure estimation was then shown to be ten centimetres on each side.

CASE II.—Miss Q., No. 34394. This patient had extensive chronic pulmonary tuberculosis of the left lung. The venous pressure was sixteen centimetres on the left and ten on the right. Following release of the left apex by thoracoplasty, the venous pressure on the left came down to seven centimetres.

The nineteen remaining cases included in this study of mediastinal venous obstruction were cases in which the obstruction was due to extramediastinal pressure. This type of venous obstruction is diagrammatically shown in Fig. 6 (IV). In fourteen of the cases the obstruction was due to pressure on the mediastinum following upper thoracoplasty. A post-operative X-ray of one of these cases is shown in Fig. 13. The upper mediastinum is shown to be shifted to the contralateral side.

Two of the cases had altered venous pressures following phrenicectomy, one followed pneumothorax, and one followed a pleural affusion which complicated pneumothorax therapy. A patient in whom a large carcinoma of the right upper lung compressed the upper mediastinum has also been included in the group where extramediastinal pressure was the cause of circulatory difficulty. (Fig. 14.) The mechanical nature of the venous obstruction in all of these cases was suggested by the fact that the venous pressures in the right and left brachial veins were unequal, being greater in each instance on the side on which the pressure was greatest in the mediastinum. The relief of the mediastinal pressure was accompanied in all cases by the relief of venous obstruction and return of the venous pressure to a normal level.



FIG. 14.—X-ray of large carcinoma of upper two-thirds of right lung causing venous obstruction by pressure on the mediastinum. Venous pressure measured twenty-four centimetres.

Obviously the treatment in this group of cases was concerned with measures to relieve the pressure on the mediastinum. In most of the thoracoplasty cases in which an elevated venous pressure was found, we also noted abnormal mediastinal shift by X-rays. These same patients occasionally showed evidences of paradoxical thoracic wall movement during respiration. This suggested that the operative procedure had been perhaps too extensive in regard to the number and length of ribs removed. We were, therefore, able to prevent such effect on the upper venous system by limiting the extent of each stage of the thoracoplasty.

When an elevated venous pressure occurred following thoracoplasty in which there was a previous pneumothorax or hydropneumothorax, adjustment of the proper relationship could be readily made by frequent interpleural pres-

sure estimations. By appropriate aspiration or injection of air, a physiological intrapleural pressure could be constantly maintained, with return of venous pressure to normal. Alteration in the venous pressure occurring in post-operative phrenicectomy cases cleared up within forty-eight hours when the intrapleural pressure was adjusted to the new position of the diaphragm. In the case of carcinoma of the lung with mediastinal pressure, little could be accomplished in the way of treatment. The lesion occupied the upper two-thirds of the lung. The presence of marked venous obstruction which produced secondary symptoms gave an additional indication for X-ray therapy in the hope of shrinking the tumor sufficiently to relieve the pressure against the mediastinum.

*Conclusion.*—In a group of surgical patients with lesions in the upper chest and the mediastinum, fifty cases were found which showed evidence of obstruction of the superior vena cava or innominate veins. Many of these patients complained of symptoms which were attributable to the effects of the disturbed venous circulation. Dilatation of the neck and arm veins was the commonest physical sign. In many of these patients, however, dilated veins were not visible and definite symptoms were lacking. In these patients the presence of venous obstruction was discovered entirely by measurement of the venous pressure. It is, therefore, important in the study of patients with lesions in or near the mediastinum to measure the venous pressure directly in order to determine accurately the status of the upper venous system.

In the great majority of this group of fifty patients it was possible to relieve the obstructive lesion surgically. In a few cases radiation therapy was effective. Venous-pressure estimations taken at intervals post-operatively were particularly valuable in determining the degree of relief of the venous obstruction. Relief of symptoms accompanied the restoration of the venous pressure to normal in each case.

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## TRAUMATIC ANEURISM OF THE SUBCLAVIAN ARTERY

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SINCE the development of aseptic surgery, operations for traumatic aneurism have increased steadily. Dupuytren,<sup>a</sup> in 1819, ligated the subclavian artery for a traumatic aneurism of the second part of the vessel—this being the first reported case, so far as we can determine from the literature, of a repair of a traumatic subclavian aneurism.

In a discussion of traumatic aneurism, one must differentiate this type from the spontaneous and no attempt will be made in this paper to discuss the entire subject of aneurism. The pathological and etiological factors differ quite markedly. In the spontaneous group, one deals primarily with diseased vessels and the aneurism develops from within, while in the traumatic type the vessels are not necessarily diseased and the exterior of the vessel is primarily involved. Whether a vessel is completely torn or merely the adventitia weakened, the traumatic aneurism shows, as described by Keen,<sup>b</sup> first, an injury to the vessel with leakage of blood into the wall; second, the formation of a thrombus which organizes into fibrous tissue; and third, the scar yields to pressure and thins out, thus forming a sac. Others, as for example, Ashhurst,<sup>c</sup> state that "a traumatic aneurism properly is not an aneurism at all but a pulsating hæmatoma, since the sac is formed, not of arterial wall, but a condensation of surrounding tissues," but this description, we feel, applies to the so-called dissecting type of aneurism.

The history is a most important and helpful guide in the recognition of traumatic aneurism of the subclavian artery. One must make a careful search in many cases to elicit the history of trauma, as in the patient reported by Kirchner,<sup>d</sup> in 1926, who received the injury ten years before coming to the hospital with the aneurism. All sorts of queer injuries have acted as etiological factors in the causation of an aneurism in the subclavian region—bullets, bayonets, crushes of the chest accompanied by fracture of the clavicle, football accidents involving fracture of the clavicle, stab-wounds with knives, scissors or swords. (See note page 88.) The results from such injuries, however, are so variable that one cannot with certainty predict whether or not an aneurism will develop.

The fact that the onset is not abrupt but in many cases very gradual, may confuse the picture. With a history of trauma, signs of swelling, expansile pulsation, a bruit, and an increasing severity of symptoms, one can usually make a diagnosis of traumatic aneurism without great difficulty.

There are numerous additional clinical findings which aid in substantiating the diagnosis, for example, those due to pressure on adjacent structures. The combination of a history of trauma and pressure signs, upon the circulatory (blanching, coldness, ischæmia, dilatation of veins distal to the point of injury) the nervous (numbness, tingling, paralyses, sweating, dilatation of one pupil), or the respiratory systems (cough, hoarseness, dyspnoea, loss of voice) makes one relatively certain of the presence of an aneurism. One difficulty not easily overcome is the differentiation between arterial and arteriovenous aneurisms of the subclavian vessels. Frequently the exact diagnosis is not known until the pathological specimen is examined, as illustrated in the case being presented. One reason for this is that there is often a considerable contraction of the scar tissue in the area involved by the stab, bullet or fracture, and this scar tissue may engulf the subclavian vein or cause it to be adherent to the tumor mass.

Having made a diagnosis of traumatic aneurism of the subclavian artery, the question arises as to what method of treatment is indicated. There are two general courses open—the conservative or the operative. The former still has its place, but much less since the development of aseptic surgery. Ashhurst<sup>c</sup> (p. 284) says that "all aneurisms (except certain forms of internal ones) should be operated upon, and nothing is gained by delay." The conservative treatment is still less in vogue for traumatic aneurisms, chiefly for two reasons—first, the vessel wall is permanently weakened (but only at the site of injury); and second, death is almost certain sooner or later if the aneurism is left alone. Good results in the operative treatment depend upon (1) prolonged and safe anæsthesia, (2) adequate exposure, (3) repair of the vessel, and (4) postoperative care. The anæsthetics most frequently used are open drop-ether inhalations, intratracheal insufflation (ether), and more recently, avertin (rectal) supplemented with ether or nitrous-oxide inhalation. We chose avertin supplemented with ether inhalation for the case we are reporting.

All of the authors seem to agree that "adequate exposure is essential." There are two routes, (1) the anterior, in which the location and type of incision seem to vary with each operator, and (2) the posterior, which passes through the posterior mediastinum and may be employed in cases involving

\* Note.

Bullets	Stab-wounds	Chest Crushes and Fractures	Football Accidents
Cases No. 16, 18, 33, 34, 37, 39, 40, 41, 44, 46, 48, 60, 66, 70, 73, 75, 83, 84, 85, 86, 87, 88, 90, 91, 92, 94, 95, 96, 97, 99, 101, 102, 104, 107, 108, 109, 111, 112, 116, 117, 118, 120, 123, 125	Cases No. 1, 2, 5, 12, 21, 22, 24, 25, 26, 27, 29, 35, 36, 42, 43, 49, 50, 52, 53, 55, 57, 61, 63, 65, 71, 72, 74, 77, 100, 113, 119, 122, 126, 127, 129	Cases No. 3, 4, 6, 14, 32, 38, 47, 59, 64, 69, 121, 128	Case No. 124

## TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

the first portion of the left subclavian artery. With the anterior approach most men agree that in order to gain adequate exposure at least a partial resection of the clavicle is necessary, and such a procedure is not detrimental to the final functional result as the clavicle regenerates quite rapidly if removed subperiosteally.

There can be no set rule for the exposure or the type of operation, as each case depends upon the location and the extent of the injury. However, in general it has been found that the traumatic variety of subclavian aneurism rarely occurs in the second portion of the vessel. The operative technic is dependent upon the findings when the vessel and aneurism are exposed. The general types of operative procedure may be summarized as follows: (1) ligation, (2) excision, and (3) repair (endo-aneurismorrhaphy), but as yet there has been no universal agreement as to the relative value of each method. For aneurism of the third part of the artery, Eliot<sup>e</sup> states that ligation of the first part and its branches (except the vertebral) is the best procedure, at times combined with distal ligation, and finally excision of the sac. Halsted<sup>f</sup> also agrees that ligation is the least dangerous and most effective. He cites only three cases of gangrene in a total of 142 (all types). He also states that "arterioplasty is dangerous in aneurism." Matas,<sup>g</sup> on the other hand, feels that his technic of endo-aneurismorrhaphy is the method of choice because: (1) it almost always permanently cures the aneurism; (2) the risk of secondary hæmorrhage is very slight; (3) gangrene of the affected vessel is rare; (4) the mortality of this operation is negligible. Others state that excision has equal merit, especially in the subclavian group. Souchon,<sup>h</sup> as early as 1895, reported seventeen traumatic cases treated by ligation with only two deaths—one due to cerebral symptoms (anæmia?), and the other to secondary hæmorrhage. Regardless of the general pre-operative plan, one has to be guided by the findings at operation and the type of repair is usually not one of choice but of necessity.

The dangers to be anticipated are hæmorrhage, either primary or secondary, shock, collapse of the lung, gangrene of the extremity, and infection. Adequate collateral circulation is not always possible and gangrene may develop. Gangrene and infection have both been markedly decreased with the advent of aseptic surgery. Waiting a sufficient time after the injury before any attempt is made to operate on the traumatized vessel is mandatory. Seventeen days according to Von Haberer,<sup>i</sup> is claimed to be the minimum length of time one should allow following injury for the organization of sufficient clot and fibrous tissue about the aneurism. To operate sooner (except in an obvious emergency) is to jeopardize the life of the patient. Granted that the patient survives, there are certain other sequelæ to consider. For example, either before or after operation there may be some nerve injury as manifested by the loss of sensation along the course of one of the trunks of the brachial plexus or perhaps by paralysis of one or more groups of muscles. Fortunately, these complications often clear up in a few months provided the duration of the



trauma has not been too long, or that complete nerve destruction has not taken place.

The post-operative treatment is extremely important in all of the cases and is relatively simple. Complete rest is absolutely essential. Whether this is obtained by the use of a cast, bandages, or splints, is of little importance, but most patients will do better with some firm support—plaster-of-Paris around the trunk and including one arm. In addition, large doses of sedatives are necessary—morphine, preferably. Cough may be a distressing symptom and should be controlled with opiates without hesitation. Long rest in bed is imperative until one is absolutely sure that the arterial wall is healed, that the collateral circulation is adequate, that adjacent structures have been restored to practically normal relationship, and that the patient's general health permits activity.

It seems evident to one reviewing the literature that traumatic aneurism of the subclavian artery is an uncommon occurrence. The diagnosis should be readily established and there should be no difference of opinion as to the treatment, as surgical interference offers the best hope of a cure.

The following table presents the cases which have been found in the literature as proven traumatic aneurisms of the subclavian artery. No attempt has been made to include either the spontaneous or the arteriovenous types of aneurisms. Owing to the difficulty of translation of all the foreign languages, there may have been an omission here and there, but we have tried to include to date all reported cases.

The list brought up to 1895 by Souchon<sup>b</sup> has been taken almost verbatim, as has also the list made by Halsted.<sup>c</sup> Additions have been made in those cases which seem to indicate a former omission. (See table, page 96.)

CASE REPORT.—O. B., Negro, male, aged twenty-three, was in a street fight July 30, 1932, and was stabbed with a knife beneath each clavicle. He was brought to the Pennsylvania Hospital in a state of shock but reacted quickly. The wounds were sutured and a rubber dam drain inserted in the wound below the middle third of the left clavicle because of its depth. There was no evidence of a collapsed lung, although there was considerable subcutaneous emphysema in the region of the drained wound and a moderate amount of subcutaneous bleeding. He improved rapidly with rest in bed and sedatives and was discharged from the hospital August 5, 1932, to be followed in the Surgical Dispensary. In reviewing the dispensary records, the following notes were significant. At the time of his first dispensary visit, August 13, 1932, there was a moderate discharge from the left infraclavicular wound. Three days later he complained of pain in the left arm. September 1, 1932, he had a swelling about the left clavicle which did not fluctuate. Ten days later, September 10, six weeks after the original injury, a note was made of a fluctuant swelling above the left clavicle which disappeared upon pressure. There was a visible pulsation and a systolic bruit. He was referred to the ward of the hospital, with a diagnosis of "arteriovenous aneurism of the left subclavian artery and vein, traumatic in character." The following day he was confined to bed and given iodides on general principles in spite of two negative Wassermann reactions. On examination it was noted that there was a mass about the size of a lemon just above the middle third of the left clavicle. There was a visible pulsation, expansile in character, a fine systolic thrill, and a pronounced bruit was

## TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

heard over the mass. On compression of the first part of the left subclavian artery, Doctor Batson, who saw the patient in consultation, found that the mass, the thrill and the bruit were obliterated. Examination of the extremities showed practically no difference in either pulse. The blood-pressure of the left arm was 120/65 and the right 130/70. Two days later the right was 114/70 and the left 114/64. No demonstrable pulmonary lesion or cardiac abnormality was found.

The mass increased slowly in size. September 30 it measured 8 by 6 centimetres, and obliteration was obtained only after considerable pressure. With the mass reduced, the blood-pressure in the left arm was 125/70 (before reduction the pressure was 125/70), while the right arm showed a pressure of 118/70. On October 7 the mass had enlarged one centimetre in diameter, measuring 9 by 6 centimetres. The pulse was 68 in the left forearm irrespective of whether or not compression was applied to the subclavian artery. By this time the wound of entrance of the original injury had healed and the patient's general condition seemed satisfactory. The right palpebral fissure was noted to be larger than the left on October 10, and the right pupil twice as large as the left. The radial pulses were equal and synchronous. No increase was noted in the venous pressure and there was no marked cyanosis of the hand. He complained of numbness of the left index finger. Because of the rapidly increasing size of the tumor mass, operation was decided upon. Accordingly, October 11, 1932, seventy-two days after the stab-wound was inflicted, he was operated upon by Doctor Lee and Doctor Mitchell, assisted by Doctors Brown, Peacock and Gallagher. He was given avertin anaesthesia—90 mgm. per kilo of body weight—and this had to be supplemented with open drop ether. The pre-operative diagnosis was traumatic arteriovenous aneurism of the left subclavian vessels.

*Operation.*—An incision was made, starting at the left sterno-clavicular articulation, extending downward and outward to the mid-axillary line at the level of the fifth interspace, and then from the starting point passing above and outward to the tip of the left clavicle. The skin and subcutaneous fascia were reflected laterally, and in order to provide adequate exposure, the following muscles with their respective fascial planes were divided—the pectoralis major and minor, the sternocleidomastoid, antero-medial margin of the trapezius, subclavian, and later the scalenus anticus. The right clavicle was resected subperiosteally, divided with a Gigli saw one and one-half inches from its outer end, the sternoclavicular articulation was entered and the clavicular portion was removed from within the joint cavity. (Fig. 1.) Strips of tape were placed under the subclavian vessels distal to their third portion for emergency control of hæmorrhage. The subclavian artery and vein were isolated after much difficulty and exposed from the distal toward the proximal portion. The external jugular vein, internal jugular vein and common carotid artery were searched for, and an attempt was made to visualize their course in the region of the root of the neck on the left side. The sac of the aneurism was exposed during this process and it was noted to be about the size of an elongated navel orange, 8 by 6 centimetres. The wall of the sac was extremely thin in spots and had to be handled with the utmost care. (See pathological report.) The mass seemed to extend upward along the left carotid sheath and the sac was fused with this sheath, and this fusion extended up to the level of the thyroid cartilage. (Figs. 1-2.) In order to complete the exposure of the sac it was necessary to make another incision through the skin and fascial planes which extended upward and medially from the middle of the incision over the clavicle and exposed the lower half and the anterior margin of the left sternomastoid muscle. This incision provided the required exposure and permitted of a slow and tedious isolation of the sac from the adjacent structures. It was noted that the internal jugular vein had apparently been flattened out by the pressure of the aneurism and that it crossed the medial surface of the mass from above downward and joined what seemed to be the left transverse cervical vein. These veins were ligated and further dissection of the tissues about the sac continued. Finally, the sac was isolated almost

completely and it was noticed that it communicated with the first portion of the left subclavian artery and possibly with the internal jugular vein at its junction with the left subclavian vein. There was considerable discussion as to the exact point of origin of the aneurism, but it was certain that it was medial to the tendon of the scalenus anticus muscle, and this was divided in order to expose the origin of the sac. The mass was pulsating very feebly and it seemed to be filled with considerable clot. While considering the proper disposition of the sac it was ruptured close to its origin from the subclavian artery and a generous stream of blood spurted forth. Pressure applied by Doctor Mitchell and later by Doctor Brown over the artery proximal to the opening and against the first rib satisfactorily controlled the bleeding. The internal jugular vein was ligated and the opening in the artery closed with four lateral mattress sutures of silk. The pressure on the first portion of the artery was then released gradually and no bleeding was noted. (Fig. 3.) No further attempt was made to determine the relation of the structures or to expose more of the vessel, as the hæmorrhage had been controlled, the

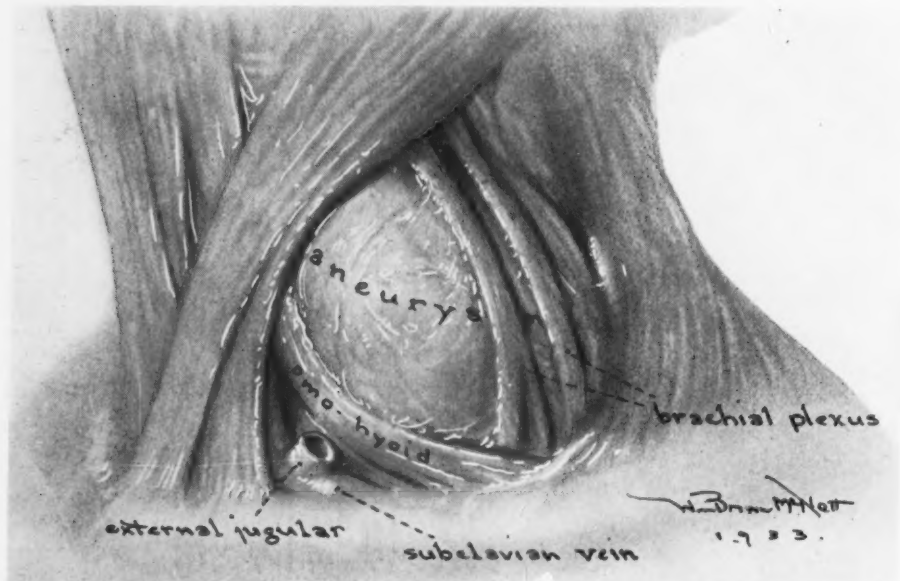


FIG. 1.—Traumatic aneurism of left subclavian artery.

aneurismal tumor had been removed at the time of its rupture, and the patient was in none too good condition.

The muscles, fascia and skin were closed as rapidly as possible and a drain was left in the outer and lower portions of the incision beneath the pectoralis minor muscle, which emerged in the anterior axillary line. The wound was dressed with a sterile dressing and the left arm held by a firm Velpeau bandage. The patient left the operating room in a moderately satisfactory condition, having received five grains of caffeine sodium benzoate (hypodermically) and an anæsthetic which was given for over five and one-half hours.

The patient had an uneventful convalescence, being kept in bed with a light plaster-of-Paris cuirasse around the chest, including the left arm. He was allowed out of bed December 25, seventy-four days after the operation, and was discharged from the hospital February 24, 1933, 135 days following the operation. Immediately post-operatively he received morphine freely and was kept under its effect for a nearly a week. Examination of the left chest January 18 showed the presence of fluid and a paracentesis thoracis revealed the presence of 750 cubic centimetres of dark reddish-brown fluid. The remaining fluid was gradually absorbed and there was no further necessity for aspiration.

sternoclavicular joint  
 articulation  
 hyoid  
 thyroid gland  
 trachea  
 pleuro-brachialis  
 the end of  
 clavicle  
 pectoralis major  
 asc. rib

Wm. Brown, M.D.

[illegible]

93

There was very little disturbance post-operatively of the vessels of the left arm. The radial pulse was never imperceptible. There was no sign of gangrene or serious impairment of circulation in the left upper extremity. The thrill present before operation was quite faint immediately following. A month later (November 11, 1932) the thrill was less but the bruit became more pronounced. It was rough, prolonged and blowing, and yet there was no sign of recurrence of the swelling. Apparently what happened, according to our explanation, was that the scar tissue resulting from the repair of the vessel (the suture line) contracted, the scar encroached upon the lumen of the vessel and thus supplied the mechanism for producing a strong, blowing murmur. The murmur also gradually disappeared, but was still present six months after the operation. (The nervous symptoms were few—a transient inability to flex the left little and ring fingers or to extend the same. There was practically no demonstrable sensory disturbance.)

An examination made six months after the operation revealed the following:

(1) *Local*.—The wound was completely healed with only a slight amount of tendency to keloid formation. There was beginning regeneration of the clavicle and full function of the shoulder-joint and left lower extremity. No tumor mass or thrill was palpable. There was still a soft blowing systolic murmur over the site of the original tumor which increased as the artery was compressed.

(2) *Peripheral*.—No abnormalities were noted. He raised the arm almost to 180°. His blood-pressure was 140/84 in the right arm, and 130/80 in the left arm. The pulses were practically equal in volume and synchronous with the apical rate.

(3) The chest examination revealed slightly less expansion over the right lower chest with somewhat diminished breath sounds. An X-ray of the chest showed practically no fluid and no evidence of any recurrence of a tumor mass.

*Pathological Report*.—The specimen consists of a saccular structure measuring 6 by 5 by 5 centimetres. Its structure externally is covered by loose areolar tissue with small lobules of fat and fragments of muscle. There is a reddish-brown discoloration of the tissue. At one point there is an opening through the wall which is eight millimeters in diameter. This is the only opening into the sac. Section made through this opening shows a rather thin-walled cavity with a laminated thrombus. This thrombus is fresher in the centre but becomes pale and dense as it forms the inner lining of the wall. At the opening through the wall and for a distance of 1.5 to 2 centimetres distalward the wall is 2.5 millimeters thick, then quite abruptly it becomes thinned out to a thickness of one millimeter or less. At the thickest point the wall does not present a clear-cut picture of arterial wall for even here the tissue is homogeneous, gray and opaque. It is this thick portion of the wall, however, which does suggest that the aneurism has arisen from an artery.

*Microscopically*.—Sections were made through the entire aneurism showing the wall intact except for an opening at the point of the attachment to the vessel wall. At this point the wall is 2.5 to 3 millimetres thick. For a distance of one to two centimetres from the opening the wall is approximately the same thickness, but distal to this it becomes greatly thinned out and in places is hardly one millimetre across. Everywhere the wall seems to be made up entirely of fibrous tissue. Near the opening the fibrous tissue is quite dense and practically avascular except the outer portion. The tissue is greatly distorted and suggests recently formed tissue rather than the wall of a vessel. In the thinner parts of the wall the vascularity is more pronounced. These vessels do not look like recently formed channels, but seem to be vessels of tissue which has been compressed into a compact stroma. The lining of the aneurism is composed of a compact layer of organizing thrombus in which there are many eosinophiles and mononuclears as well as scattered polymorphonuclear leucocytes. Likewise in the compressed tissue of the outer portion of the wall which includes atrophic striated muscle fibres, one sees a considerable number of mononuclear cells associated with thick-walled vessels of very small calibre. The cavity of the aneurism is filled with a thrombus mass, some of which is rather fresh while other parts are undergoing softening. Verhoeff-VanGieson stain, the special stain for elastic



## TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

tissue, fails to show elastic fibres in the wall at any point, and, too, the tissue takes a light pink to a dark red stain, indicating that the wall is fibrous tissue with no smooth muscle demonstrated.

It is to be regretted that the histological picture does not present sufficient evidence to warrant a definite statement as to its mode or development or the vessel from which it arose. The rarity with which syphilitic lesions are found in the larger branches of the



FIG. 4.—Photograph taken twelve months after excision of a traumatic aneurism of the left subclavian artery.

aorta tend to exclude this mode of development. The presence of a mild inflammatory reaction in the wall and surrounding tissues points to the possibility of a mitotic aneurism. The history suggests that there might have been a small traumatic aneurism represented by a thick portion of the wall, and later this became weakened by the secondary infection with the enlargement as indicated by the thinner part of the wall.

*Diagnosis.*—Aneurism of the left subclavian artery.

TABLE

No.	Operator and Publication	Sex	Age	Cause	Operation	Result
				Stab-wound below clavicle	Compression	Cure
1.	Ravatan, 1762: Abhandl. von Schuss- Heb- und Stichwunden, Strassb., p. 433, 1767.	M				
2.	Larrey, 1811: Cited by Dünow: In Diss. Heidelberg, 1904.	M		Sabre cut	Aneurism disappeared by twentieth day	Cure
3.	Colles, A., 1811: Edinburgh Med. and Surg. Jour., vol. II, p. I, 1811.	M	33	Contusion of supraclavic- ular region	Ligation of first portion	Hæmorrhage, pleura injured, death
4.	Mott, V., 1818: New York Med. Re- pository. Cited by Koch: Arch. f. klin. Chir., vol. 10, p. 330, 1869.	M	57	Fall on shoulder	Ligation of innominate	Suppuration, hæm- orrhage, death on 26th day
5.	Dupuytren, 1819: Leçons orales de clinique Chir., vol. 4, p. 525, 1834.	M	37	Punctured wound	Ligation of second portion	Abscess, cure
6.	Bullen, 1823: London Med. Reposi- tory, vol. 20, p. 190, 1823.	M	60	Barrel fell on shoulder	Ligation of second portion	Hæmorrhage, cure
7.	Gibbs, H. L., 1823: Med.-Chir. Trans., vol. 12, p. 531, 1823.	M	35	Struck with a rope	Ligation of third portion	Cure
8.	Sawinkoff, 1823: Jour. de Chir. u. Augenheilk., vol. 6, p. 662, 1824.	M	30	Carried weights on rope over shoulder	Ligation of third portion close to scalenus anticus	Cure
9.	Arendt, 1827: Cited by Dietrich: Ver- mischte Abh.a.d.Geb. der Heilk. von einer Ges. prakt. Aerzte zu St. Peters- burg, p. 134, 1830.	M	36	Blow on shoulder	Ligation of innominate	Pyæmia, exhaustion. Death on 8th day
10.	Auchincloss, 1833: Edinburgh Med. and Surg. Jour., vol. 45, p. 324, 1836.	M	65	Carried heavy weight on shoulder	Ligation of second portion	Cerebral symptoms, coma, death
11.	O'Reilly, 1833: Cyclop. Anat. and Physiol., vol. 4, p. 616, 1852.	M	50	Dislocation of shoulder	Ligation of third portion	Gangrene of fingers. Cure
12.	Lallemand, F., 1834: Arch. gen. de Med., vol. 7, p. 477, 1835.	M		Sabre wound	Ligation of second portion. Wound 3 inches deep	Cure
13.	Pereira, J., 1835: Jour. de sc. med. de Lisbonne, vol. 1, p. 149, 1835.				Ligation of third portion. Artery deep seated	Cure

# TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

14. Lizars, 1837: Lancet, vol. 2, p. 445, 1837.	M	30	Fell on right arm, fractured left clavicle	Operation 4 months later	Hæmorrhage, death 22 days after operation Cure
15. Earle, 1835: London med. Gaz., vol. 6, p. 241, 1830.	M	54	Onset gradual in iron-plate worker	Ligation of third portion	
16. Wattman, 1843: Arch. f. klin. Chir., vol. 10, p. 228, 1860.	M	22	Gunshot wound	Ligation of third portion	Hæmorrhage, death
17. Warren, J. C., 1844: Lancet, vol. 2, p. 620, 1845.	M	30	Dislocation of shoulder	Ligation of second portion	Abscess, hæmorrhage, cure
18. Auvert, 1848: Selecta Praxis Med.-Chir. Tab., vols. 55, 56, Paris, 1848.	M	50	After reduction of dislocated shoulder	Ligation of first portion	Hæmorrhage, death
19. Manec, 1848: Gaz. des. Hop., p. 447, 1849.	M	18	Gunshot wound	Ligation of third portion	Air entered external jugular, cure Cure
20. Mott, V., 1850: Wyeth's Essays, p. 216, 1879.			Fall of cask on shoulder, subclavio-axillary aneurism	Ligation of third portion	
21. Bonnet, 1853: Bull. de la Soc. de Chir., vol. 3, p. 608.			Stab-wound	Aneurism evacuated 4 wks. later	Cure, arm paralyzed
22. Roux, 1855: Quarante Années de Pratique Chir., vol. 2, p. 391, Maasson, Paris, 1855.	M	35	Puncture wound of axilla	Ligation of second portion	Hæmorrhage, death
23. Pitha, 1856: Arch. klin. Chir., vol. 10, p. 211, 1869.	M	54	Rupture of circumflex artery in reducing dislocation, high axilla aneurism, tumor size of man's head	Ligation of second portion	Pneumonia, death
24. Cuveiller, 1859: Gaz. des hop. de Par., vol. 23, p. 130, 1860.	M	20	Bayonet wound	Ligation of first portion, distal end of subclavian opened, proximal end closed	Hæmorrhage, death
25. Fischer, 1861: Cited by Dünow: In Diss. Heidelberg, 1904.			Stab-wound in left clavicular region		After one year marked swelling in this region, dyspnoea, cold sensation in arm

TABLE (Continued)

No.	Operator and Publication	Sex	Age	Cause	Operation	Result
26.	Langenbeck, No. 1, 1862: Cited by H. Schreff: In Diss., Berlin, 1863.	M	34	Stab-wound, diffuse sub-clavio-axillary aneurism	Ligation of second portion	Pyæmia, death
27.	Uhde, 1863: Cited by Koch: Arch. f. klin. Chir., vol. 10, p. 240, 1869.	M	20	Stab-wound under right clavicle	On ninth day evacuation of clots, could not locate subclavian artery, tamponade	Death 1½ hours after operation
28.	Smyth, 1864: New Orleans Med. Rec., vol. 1, p. 4, 1866.	M	32	Violent stretching of arm	3 mos. after injury tied carotid and innominate simultaneously	Died 10 years later from hæmorrhage from original sac
29.	Thiersch, 1865: Jaccoud's Dictionnaire, vol. 33, p. 419, 1882.	M	28	Puncture wound	Ligation of third portion, incision of sac	Hæmorrhage, pyæmia, death
30.	Morton, T. G., 1866: Amer. Jour. Med. Sci., vol. 54, p. 70, 1867.	M	51	Bruise from carrying planks	Ligation of a second portion and later amputation	Suppuration, gangrene, hæmorrhage, cure
31.	Bickersteth, 1868: Lancet, vol. 2, p. 815, 1872.	M	40	Strain	Ligated with lead wire, removed and silk ligatures applied	Death on 6th day
32.	Wilms-Hahn, 1868: Deutsche med. Wchnschr., vol. 18, p. 1146, 1892.			Injury of clavicle	Several months later incision of sac and ligation of artery	Cure
33.	Maddin, T. L., 1868: Nashville Med. and Surg., n.s., vol. 4, p. 59, 1868.	M	26	Gunshot wound by Minié ball, subclavio-axillary aneurism	Ligation of third portion, close to scalenus anticus; also of anterior scapular artery	Cure, later on recurrence of aneurism
34.	Socin, 1870: Cited by Dunow: In Diss. Heidelberg, 1904.			Gunshot wound 4 cms. below right clavicle	Operation for aneurism 4 mos. later, provisory ligation and incision of sac, hæmorrhage demanded immediate ligation	Death 12 days after operation from hæmorrhage
35.	Marchesano, V., 1875: Osservatore medico, Palermo Siciliano, ser. 3, vol. 5, p. 327, 1875.	M	34	Wounded by sharp gouge	Ligation of first portion	Ligature slipped, death
36.	Will, 1875: Glasgow Med. Jour., n.s., vol. 7, p. 173, 1875.	M		Stab-wound left side	Repeated hæmorrhages 20 days after injury	Death followed

# TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

37. Ayres, S. C., 1875: Med. and Surg. Hist. War of Rebellion, vol. 1, p. 546, 1875.			Bullet wound, fracture of clavicle, hæmorrhage one month later from subclavian aneurism			Ligation of first portion	Death 1 hour post-operatively
38. Heath, C., 1880: Tr. Roy. Med. and Chir., vol. 45, p. 65, London, 1880.	M	48	Run over Sept., 1878, fract. ribs 1-6, left subclavian aneurism			Amputation at shoulder, Nov., 1878	Death, Jan. 18, 1879
39. McKinnon, J. A., 1880: Virginia Med. Monthly, vol. 7, p. 524, 1880.	M	21	Pistol wound, subclavian maxillary aneurism			Ligation of third portion close to scalenus anticus, bag of shot over wound stopped hæmorrhage	Hæmorrhage, cure
40. Michel, 1883: Amer. Jour. Med. Sci., n.s. vol. 86, p. 439, 1883.	M	25	Gunshot wound by Minié ball, subclavio-axillary aneurism			Ligation of second portion, artery deeply seated	Hæmorrhage, death
41. Langenbeck, No. 2, 1884: Verhandl. der deutsche Ges. f. Chir., vol. 13, p. 108, 1884.			Bullet wound, subclavio-axillary aneurism			Incision of tumor and ligation of both ends	Repeated hæmorrhage, cure
42. Langenbeck, No. 3, 1884: <i>Ibid.</i>			Knife wound, subclavio-axillary aneurism			Clavicle divided, ligation of both ends	Pyæmia, death
43. von Bergmann, 1884: Verhandl. der deutsche Ges. f. Chir., vol. 13, p. 106, 1884.	M	30	Stab-wound left side			Compression, 9 weeks after injury	Cure
44. Lewtas, J., 1889: Brit. Med. Jour., vol. 2, p. 312, 1889.	M	20	Gunshot wound			Incision of sac with removal of clots, no ligation of wounded end of artery, ligation of innominate and of common carotid	Cure
45. Twynam, 1890: Lancet, vol. 1, p. 1352, 1890.	F	18	Thrown from horse against a stump			Operation 31 days later, ligation of innominate and carotid	Death 18 hours after operation
46. Parke, T. D., 1890: Med. Rec., vol. 37, p. 184, 1890.	M	40	Gunshot wound			Ligation of third portion	Cure
47. Bowly, A. A., 1891: Tr. Path. Soc., vol. 43, p. 79, London, 1891.	M	60	Was run over, fracture ribs and left clavicle, subclavian aneurism			None	Death before operation



TABLE (Continued)

No.	Operator and Publication	Sex	Age	Cause	Operation	Result
48.	Miles, 1893: Med. News, vol. 63, p. 208, Philadelphia, Pa., 1893.	M	37	Gunshot wound	Provisional loop ligature on first portion, incision of sac, ligation of both ends	Cure
49.	Rotter, J.: Berlin klin. Wehnschr., vol. 40, p. 279, 1893.	M	26	Stab-wound	Ligation of third portion 2 wks. after injury	Cure
50.	Wedekind, 1894: Berlin klin. Wehnschr.	M	22	Stab-wound on left side, arteriovenous aneurism	None	Cure
51.	Thorburn, W., 1895: Brit. Med. Jour., vol. 1, p. 909, 1895.	M	51	Severe blow, left subclavian aneurism	Distal ligation between second and third portions, electrolysis	Cure
52.	Veiel, 1895: Med. Correspondenz Bl. d. Württemb. aerzt. lands., vol. 45, p. 123, 1895.	M	23	Stab-wound in right subclavicular region, aneurism	Ligation of subclavian outside of the scalenus anticus, ligation of axillary artery and veins	Cure, but marked trophic and vascular disturbances
53.	Schally, 1896: Prag. med. Wehnschr., p. 597, 1896.	M	25	Stab-wound in left cervical region	Compression	Cure
54.	Heuston, F. T., 1897: British Med. Jour., vol. 1, p. 714, 1897.	M	50	Heavy board fell on shoulder	Ligation of third portion with catgut	Cure
55.	Croly, H. C., 1898: Trans. Roy. Acad. in Ireland, vol. 16, p. 155, 1898.	M	37	Stabbed with tailor's scissors, below left clavicle	Proximal ligation second portion with ox peritoneum	Cure
56.	Schumpert, T. E., 1898: Med. Rec., vol. 54, p. 338, 1898.	M	56	Sudden onset, while chopping timber	Double ligation, first portion	Cure
57.	Ziegler, 1899: Münch. med. Wehnschr., vol. 46, p. 553, 1899.	M	17	Stab-wound in right chest	Operation 20 days after injury, ligation of subclavian, tampon	Cure
58.	Jungst, 1902: Beitr., z. klin. Chir., vol. 34, p. 307, 1902.	F	35	Bullet wound	Ligation with silk, first portion	Cure. Injury to thoracic duct
59.	Gallois, 1901: Rev. de Chir. p. 22, 1901.	M	25	Thrown from a mule, striking his right shoulder, fracture of clavicle, aneurism	Resection of clavicle, incision of sac	Hæmorrhage, death 4 days after operation
60.	Matas, R., 1901: Amer. Jour. Surg. and Gynec., vol. 15, p. 185, 1901.	M	24	Bullet wound of right supraclavicular region	Division of artery between first and third portions, lateral suture of venous orifice, osteoplastic resection of clavicle	Recovery, partial loss of hand and forearm from artificial ischæmia

# TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

61. Legueu, 1902: Bull. de la soc. de Chir., p. 400, 1902.	M	35	Knife wound of brachial plexus and subclavian, self-inflicted by mental patient, aneurism in inter-sclenic space	Operation 10 days later, double ligation	Cure
62. Banks, Sir Wm., 1903: Lancet, vol. I, p. 103, 1903.	"Young Healthy Man"		Railway crush	Attempted ligation first portion left subclavian artery in thorax	Death from pleurisy
63. Hinder, H. C., 1903: Australian Med. Gaz., vol. 22, p. 69, 1903.	M	32	Stab-wound above left clavicle	Ligation third portion	Well 6 months after operation
64. Taylor, W., 1903: ANNALS OF SURGERY, vol. 38, p. 33, 638, 1903.	M	60	Fell on left shoulder, fracture clavicle, subclavian aneurism	Proximal ligation, incision of aneurism, rupture of vein, pack	Cure
65. Dunow, 1904: In Diss. Heidelberg, 1904.	M	21	Stab-wound in left clavicular region	Operation 18 days after injury, provisory ligation of subclavian artery, resection of clavicle, extirpation of aneurism	Cure
66. Saigo, K., 1906: Deut. Zeit. f. Chir., vol. 85, p. 557-640, 1906.	M	25	Shot above right clavicle	Apr. 6, 1905, ligation and division of innominate; Aug. 4, 1905, excised after ligation of both subclavian artery and vein proximally and distally	Recovery
67. Delbet, P., 1910: Bull. et mem. Soc. de Chir., vol. 36, p. 1114, 1910.	M		Not given; traumatic aneurism in supraclavicular fossa	Ligation of subclavian artery within thorax, also distal to sac; sac opened and permanent tamponage used	Recovery
68. Duval, Pierre, 1910: Reported by Schwartz: Ed. Bull. et mem. Soc. de Chir., n.s. vol. 36, p. 874, 1138, 1910.	M	33	Injured by shaft of wagon while bicycling; left supraclavicular region	Aug. 8, 1910, incision of aneurism, ligation of two ends	Death few hours post-operatively
69. Van der Goot, D. H., 1910: Nederl. Tijdschr. v. Geneesk., vol. 45, p. 2, 2311, Amsterdam, 1910.	M	66	Fell off bench 3 ft. high and fractured clavicle (June, 1904); noted aneurism Sept., 1904	Operation Dec. 19, 1905, distal ligation	Recovery
70. Franz, 1911: Deutsche militär-arztl. Zt., vol. 40, p. 665, 1911.	M		Pistol wound of left chest	Operation 10 wks. later, excision of sac	Suppuration, wound reopened, recovery, function good

TABLE (Continued)

No.	Operator and Publication	Sex	Age	Cause	Operation	Result
71.	Browne, C. G., 1911: Brit. Med. Jour., vol. 2, p. 1534, 1911; also Jour. Roy. Army Med. Corp., vol. 18, p. 71, 1912.	M	21	Bayonet wound left sub-clavio-axillary aneurism	Aug. 28, 1911, ligation at inner border scalenus anticus wound drained	Recovery
72.	Rubritius, H., 1911: Beitr. z. klin. Chir., vol. 76, p. 144, Tub., 1911.	M	21	Stab-wound, second portion of left subclavian artery, Sept. 13	Op. I, Oct. 5, 1909, gradual occlusion of artery in first portion with rubber tube; op. II, Oct. 27, 1909, rubber tube replaced by 2 silk sutures; op. III, Apr. 25, 1910, resection of 7-10th ribs for empyema	Recovery
73.	Rubritius, H., 1911: <i>Ibid.</i>	M	21	Revolver shot, left sub-clavicular region	Double ligature and resection between ligature, incision of sac, peripheral ligation (method of Antyllus)	Recovery
74.	Rubritius, H., 1911: <i>Ibid.</i>	M	25	Stab-wound left side neck, swelling 10 days later	Digital compression	Recovery
75.	Wieting, Prof., 1912: Zentralb. f. Chir., vol. 39, p. 1156, Leipzig, 1912.	M	35	Shot in left back Dec. 24, 1911	Jan. 4, 1912, ligation first portion—thick celluloid thread, aneurism opened and clots removed, sac stuffed with gauze and wound closed	Recovery
76.	Magandda, P., 1913: No. 1, Riv. de Pat. Nervosi, vol. 18, p. 83, 1913.	M	48	Was run over, injuring left side—subclavian aneurism	Ligation, ? portion	Improved
77.	Magandda, P., 1913: No. 2, <i>ibid.</i>	M	45	Knife wound, left deltoid region	Ligation, ? portion	Recovery
78.	Thompson, J. E., 1915: ANNALS OF SURGERY, vol. 61, p. 641, 1915.	M	46	Dock laborer	Ligation of innominate	Died 67 days after operation
79.	Bier, A., 1915: Deutsche med. Wehnschr., vol. 41, p. 121, 157, 1915.	M		Intrathoracic war wound	Rupture of sac during operation, ligation of subclavian artery at origin, ligation also peripherally, tamponade proximal and distal ligation, incision of sac and tamponade	Death 5 days post-operatively, cerebral thrombosis
80.	Bier, A., 1915: <i>Ibid.</i>			War wound		Cure

# TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

81. Bier, A.: }	Both mentioned without details of cause and treatment or end-results; operative pictures of war aneurisms				
82. Bier, A.: }					
83. Von Haberer, 1915-1916: No. 1, Arch. f. klin. Chir., vol. 107, p. 611, 1915-1916.	M	26	Gunshot wound, 8 cms. of left subclavian artery destroyed, Sept. 8, 1914	Ligation, distally and proximally, Nov. 4, 1914	Recovery
84. <i>Ibid.</i> , No. 2.	M	22	Oct. 20, 1914, gunshot wound, left	Double ligation, sac opened, drainage	Died at operation
85. <i>Ibid.</i> , No. 3.	M	34	Gunshot, right side	Numerous ligatures necessary owing to multiple connections of sac, extirpation of sac	Recovery
86. <i>Ibid.</i> , No. 4.	M	23	Gunshot, left subclavian artery, Oct. 22 (?)	Jan. 5, nerves imbedded in aneurism, many veins ligated, extirpation of sac, double ligation	Recovery
87. <i>Ibid.</i> , No. 5.	M	21	Gunshot, left, Feb. 8, 1915	Feb. 26, extirpation of sac, lateral suture (3 stitches)	Recovery
88. <i>Ibid.</i> , No. 6.	M	22	Mar. 25, (?), gunshot, subclavio-axillary aneurism	Apr. 10, extirpation of sac, double ligation, circular suture	Recovery
89. <i>Ibid.</i> , No. 7.	M	28	Nov. 25, war wound, right	Ligation of jugular vein, subclavian and thyrocervical trunk, circular suture after double ligation	Recovery
90. <i>Ibid.</i> , No. 8.	M	20	Mar. 23, (?), gunshot, left side	Resection of 5 cms. of artery, extirpation of sac, circular suture, May 20	Recovery
91. <i>Ibid.</i> , No. 9.	M	30	July 18, 1915, gunshot, right	Aug. 6, lateral suture of artery, distal and proximal lig. of vein	Recovery
92. <i>Ibid.</i> , No. 10.	M	23	Sept. 6, (?), gunshot, left side	Oct. 1, ligation of innominate, extirpation, lateral suture of artery	Recovery, slow healing
93. <i>Ibid.</i> , No. 11.	M	21	Oct. 6, 1915, wounded, right subclavian aneurism	Circular suture	Pyo-pneumothorax rib resection, recovery, discharge Jan., 1916
94. <i>Ibid.</i> , No. 12.	M	34	May 26, 1916, gunshot	Lateral suture, June 5	Recovery
95. <i>Ibid.</i> , No. 13.	M	22	May 29, 1916, shrapnel wound	Circular suture	Improved

TABLE (Continued)

No.	Operator and Publication	Sex	Age	Cause	Operation	Result
				Gunshot wound	Lateral suture	
96. <i>Ibid.</i> , No. 14.		M	20			
97. <i>Ibid.</i> , No. 15.		M	29	June 3, 1916, gunshot	Circular suture, June 17	Abscess at exit of wound, partial mobility of upper extremity
98. <i>Ibid.</i> , No. 16.		M	22	Sept. 5, war wound, left subclavian artery	Resection of 5 cms. of artery, circular suture, Sept. 14	Nerve injuries, recovery
99. <i>Ibid.</i> , No. 17.		M	28	Oct. 16, gunshot, left subclavian aneurism	Oct. 23, lateral suture	Injury of thoracic duct, recovery
100. Griffiths, C. A., 1915-1916: Brit. Jour. Surg., vol. 3, p. 299, 1915-1916.		M	28	Bayonet wound Dec. 7, 1914, subclavian aneurism, third portion	Dec. 21, 1915, ligation 2, sac opened, ill defined, little else than laminated clot	Recovery
101. Makins, G. H., 1915-1916: No. 1, Brit. Jour. Surg., vol. 3, p. 353, 1915-1916. (Under Dr. Gray.)		M		Bullet wound, right, second portion, severe primary hæmorrhage	Ligation second portion fourteen days after injury	Death on table, respiratory failure
102. <i>Ibid.</i> (Under Dr. Butler), No. 2.		M		Bullet wound—right, third portion	None, complete rest.	Death, 3 hours post-operatively
103. Zahradnecky, 1916: Zentral, fur. Chir., vol. 43, p. 62, 1916.				Reports two cases of traumatic aneurism of subclavian; details not obtained		Transferred to another hospital, right hæmothorax
104. Reidel, K., 1917: Deutsch. Med. Wchnschr., vol. 43, p. 230, 1917.		M		Gunshot, left subclavian aneurism	None, treated by compression	Recovery
105. Ballance, C., 1918: Jour. Roy. Army Med. Corp., vol. 31, p. 417, 1918.		M	31	July, 1916, shrapnel aneurism second and third portions, tumor noted Jan., 1918	Feb. 14, 1918, ligation first portion with kangaroo tendon	Recovery
106. Tubby, A. H., and Banister, J. B., 1918: Lancet, vol. 1, p. 902, 1918.		M		Shell fragment, Nov. 2, 1917, right second portion	Nov. 29, ligation proximally and distally to aneurism, sac ruptured	Death before return of consciousness



# TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

107. Barling, G., 1918: Brit. Jour. Surg., vol. 5, p. 514, 1918.	M	33	Case of two aneurisms resulting from penetration of shell fragment, one of first part of right subclavian; the other of the thoracic aorta, April 11, 1918	April 28, 1918, wound packed—because of hemorrhage	Death, May 6, 1918
108. White, J. S., 1918: Brit. Med. Jour., vol. 2, p. 131, 1918.	M	35	Gunshot, Aug. 16, 1917, sacular aneurism second portion	Op. I, Dec. 8, 1917, (Col. A. M. Connell) stout catgut around base of aneurism; Op. II (White, J. S.) Jan. 2, 1918, ligation junction of first and second portions with double strand No. 1 catgut	Recovery
109. Halsted, W. S., 1920: Johns Hopkins Hosp. Surg. Hist., No. 46179, J. H. H. Reports, vol. 21, p. 1-96, 1920.	M	29	Shot in back 4 yrs. before admission, noted swelling 3 yrs. after injury	April 26, 1918, ligation of left common carotid and left subclavian artery near aortic origins, wound sealed	Recovery
110. Hume, D. W.: Brit. Med. Jour., vol. 2, p. 243, 1920.	M	20	Shell fragment, Apr. 22, 1917, second and third portions	June 16, 1917, ligation, silk; part not given	Recovery
111. Pfanner, 1922: Wien. klin. Wchnschr., vol. 35, p. 308, 1922.			Gunshot, left	Extirpation of sac, repair two-thirds circumference of artery by suture	Recovery
112. Hertzler, A. E., 1923: Surg. Clin. North Amer., vol. 3, p. 1507-1512, 1923.	M	43	Gunshot, 1921, right subclavian aneurism	Op. I, Apr. 24, 1922, ligation innominate—double linen including sheath; Op. II, Jan. 13, 1923, ligation of common carotid and vertebral arteries	Improved
113. Cassanello, R., 1923: La Riforma Med., vol. 39, p. 242, 1923.	M	19	Stiletto wound, left subclavian aneurism	Ligature (double) resection of sac, drainage	Pyopneumothorax, recovery
114. Lehman, R., 1924: Monat. f. Unfall., vol. 31, p. 78, 1924.	M	23	Shell wound, left subclavian and innominate aneurism	None, almost normal after 2 1/2 yrs.	Recovery
115. Chianello, 1925: Cultura med. Mod., vol. 4, p. 42, 1925.			Large traumatic aneurism	Extirpation	Cure

TABLE (Continued)

No.	Operator and Publication	Sex	Age	Cause	Operation	Result
116.	Kirchner, W. C. G., 1926: No. 1, Surg., Gynec. and Obstet., vol. 43, p. 2, 764, 1926.	M	39	Shot in left shoulder, 1913	Operation, 1923, ligation, No. 2 chronic catgut and imbrication	Recovery
117.	Constant, 1926: Bol. de la Soc. de Cir. de Chile, vol. 3, p. 306, 1926.			Gunshot wound right side	2½ mos. later preliminary ligation of axillary, temporary exarticulation, ligation of external jugular, ligation of subclavian vein and artery	Recovery
118.	Kirchner, W. C. G., 1927: No. 2, Jour. Missouri Med. Assn., vol. 24, p. 35-38, 1927.	M	41	Bullet wound, 1917, left subclavian aneurism, 1927	Ligation first portion	Recovery
119.	Schindler, 1928: Zentralbl. f. Chir., vol. 55, p. 1300, 1928.	M	28	Stab and shell wound	Resection of aneurism	Cure
120.	Arce, 1928: J. Bol. y. trab. de la Soc. de cir. de Buenos Aires, vol. 12, pp. 129-132, 1928.	M	26	Gunshot, left subclavian aneurism	Extirpation of sac with double ligature	Recovery
121.	Chapman, C. L. G., 1929: Brit. Med. Jour., vol. 2, p. 49-50, 1929.	M	33	Fracture clavicle, Aug. 19, 1928, left subclavian aneurism	Oct. 16, 1928, sac ruptured, edges oversewn, common carotid and innominate ligated	Empyema, right, recovery
122.	Elkin, D. C., 1929: ANNALS OF SURGERY, vol. 90, p. 1104-1106, 1929.	M	18	Stabbed with knife, right side of neck — brachial plexus paralysis subclavian aneurism	Ligation—proximally and distally, sac opened, obliterative aneurismorrhaphy	Recovery

# TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

123.	Caldrick, S. L., 1930: Surg. Clin. of North Amer., vol. 10, p. 973-977, 1930.	M	20	Shot Oct. 8, 1929, right subclavian aneurism, third portion	Jan. 9, 1930, repair of sac aneurismorrhaphy	Recovery
124.	Cayford, E. H., and Tees, F. J., 1931: Canad. Med. Assn. Jour., vol. 25, p. 450-452, 1931.	M	22	Fractured clavicle playing football	Op. I, Jan., 1931, modified matas-endo-aneurismorrhaphy; Op. II, Feb., 1931, ligation for leak in arterial wall proximal to repair	Recovery
125.	Eliot, E., Jr., 1932: No. 1, Tr. Amer. Surg. Assn., vol. 50, p. 190-202, 1932.	M	30	Bullet, right subclavian aneurism	Not known (done by another surgeon)	Living, not cured
126.	Eliot, E., Jr.: No. 2, <i>Ibid.</i>			Stab-wound, subclavian aneurism	Type not known	Death within 24 hours
127.	Eliot, E., Jr.: No. 3, <i>Ibid.</i>			Stab-wound, right subclavian aneurism	Attempt to establish arterial continuity	Death 24 hrs. post-operatively
128.	Nelson, H. P., 1932: St. Barth. Hosp. Rev., vol. 65, p. 219, 1932.	M	20	Fracture clavicle, 1918, subclavian aneurism 21 mos. later	Op. I, May 21, 1932, posterior extra-pleural mediastinotomy, sac opened and packed; Op. II, May 22, ligation of innominate with surgical tape—anterior approach	Death 24 hours after second operation, cause, shock
129.	Lee-Mitchell-Peacock, 1934: ANNALS OF SURGERY, vol. 100, p. 87-110, 1934.	M	23	Stab-wound below clavicle	Lateral suture first portion subclavian artery	Cure, no disability

SUMMARY

(1) We have collected from the literature the records of 128 cases of traumatic aneurism of the subclavian artery and report one case originating from the first portion of the artery which was successfully excised and the opening in the artery closed with lateral sutures.

(2) This review covering a period of 172 years would seem to show that this type of aneurism is unusual.

(3) The diagnosis should be established without any difficulty.

(4) Though there are records of a few cases of spontaneous recovery, the best hope of a cure is offered by surgical interference.

We wish to acknowledge our obligation to Doctor Batson for the opportunity to plan the exposure of the operative field in the Anatomical Laboratory of the Graduate School of Medicine of the University of Pennsylvania.

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## REMOVAL OF A BULLET FROM THE POSTERIOR WALL OF THE LEFT VENTRICLE OF THE HEART

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FRED B., aged thirty-eight, was admitted to the Manchester Royal Infirmary September 4, 1920, with the following history. Prior to the Great War he was a non-commissioned officer in the regular forces and, in August, 1914, he crossed to France with the first division of the first British Expeditionary Force. He received a slight shrapnel wound in the right side of the neck at the first battle of Ypres, which healed rapidly. September 15, during the battle of Loos, a machine-gun bullet glanced from off the top of the trench in which he was standing and entered the front of the left side of his chest. He remembers nothing from that time until two days later when he found himself in the Royal Herbert Hospital at Woolwich. It was there noted that the bullet had entered the left breast one inch below and to the outer side of the nipple, had traversed the lung, causing slight temporary hæmoptysis, and had lodged. After two months in bed he was transferred to an auxiliary hospital for five months, and was then placed on home service. Three months later he had a syncopal attack while on parade and was returned to hospital whence, in September, 1916, he was discharged from the service and granted a full pension. His chief complaint at that time was of attacks of palpitation and dizziness which sometimes caused him to fall over but did not give rise to any pain.

Later, he obtained sedentary employment as a clerk and continued as such, with short intermissions from recurrences of his symptoms, until March, 1920. He then commenced with attacks of severe pain of a "stabbing" character over the region of the heart, accompanied by palpitation and dizziness. These became so frequent that he was obliged to cease work; he was sent to the Ministry of Pensions Hospital at Fazackerley, near Liverpool, and thence to the Liverpool Royal Infirmary. There the presence of the bullet was verified by röntgenoscopy, but it was considered inadvisable to attempt its removal. As, however, the continuance of his attacks rendered him quite incapable of physical effort, and as he "had to be led about like a big child," he sought and obtained admission to the Manchester Royal Infirmary.

Physically, he was at that time (April 9, 1920) well-developed, muscular and well-nourished and, while lying quietly in bed, suffered no apparent discomfort; his pulse was of good volume, regular but rather quick, averaging 90 per minute, while his blood-pressure was 120. On making such effort as getting out of bed his pulse would rise to 140 and become feeble and fluttering, with occasional intermissions; in some attacks the palpitation was accompanied with severe precordial pain, trembling of the limbs and profuse sweating. The scar of entrance of the bullet was situated one inch below and to the outer side of the left nipple. Röntgen-screen examination did not indicate any injury to the bony structures of the chest and the bullet appeared to be lying in the posterior mediastinum, almost in the middle line, and to be adherent to the posterior wall of the pericardium. At a subsequent examination (September 30, 1920) it was considered to be inside the pericardium and outside the heart, but owing to the rapidity of the heart's action, the position of the bullet was difficult to define and it seemed to have a rapid circular movement. Several radiograms were taken, but owing to this movement, they showed merely a blurred shadow.

The patient, having had the risks of operation fully explained, elected to take his chance therewith since the attacks were becoming more frequent and more painful

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and quite incapacitated him from any useful life. Accordingly, October 9, 1920, operation was undertaken under ether anaesthesia administered by the intra-tracheal route. I made the incision along the mid-sternal line from the level of the second costal cartilage to a point one inch below the tip of the ensiform cartilage. The sternum was sawn transversely at the level of the third costal cartilage and the lower segment divided longitudinally along the mid-line. By means of "Tuffier's rib-retractor" the two halves of this lower segment were forcibly separated and a working distance of some three inches obtained between them. The pericardium was exposed without damage to either of the pleural sacs, but on attempting to open the pericardial sac, this was found obliterated by adhesions between its parietal and visceral layers, the separation of which was rather a slow process and was accompanied by much capillary oozing. Having freed the anterior surface and apex of the heart it was possible to lift the latter forwards between the halves of the sternum and thus gain access to the posterior surface. It was noted, however, that this manœuvre caused the blood-pressure, which was being continuously registered, to fall steadily and rather quickly, much to the alarm of the anaesthetist, who requested that the heart be replaced. The blood-pressure was thus restored and thereafter the heart was alternately lifted forwards to allow the separation of the parietal pericardium from its posterior surface and then replaced to permit restoration of the blood-pressure. Finally the posterior surface of the heart was freed, when the base of the bullet could be felt projecting slightly from the surface of the left ventricle about one inch and three-quarters below the auriculo-ventricular groove. It was lying very obliquely in the posterior wall of the left ventricle with its apex pointing upwards and inwards. Since the depth to which it had penetrated the heart-muscle was not known, a catgut suture was passed, by means of a strongly curved small Hagedorn needle, in a circular fashion around the base of the bullet, in case severe hæmorrhage should follow its withdrawal. By means of forceps seizing its base the bullet was slowly rotated on its long axis so as to loosen it, and as no hæmorrhage followed, it was gradually withdrawn completely and its track obliterated by tying the catgut suture. The pericardial incision was closed with fine catgut, the rib-retractor removed, the three portions of the sternum approximated with stout catgut and the skin incision closed without drainage. The operation lasted seventy-five minutes and was well borne, the only anxious moments being, as already mentioned, when the apex of the heart was displaced forwards. Convalescence was uneventful except for a slight attack of bronchitis during the first week. December 3, he was transferred to the Ministry of Pensions Convalescent Camp at Blackpool, where he rested several months.

In 1923 he obtained employment as a laborer with a firm of oil refiners, and was obliged to "haul and load into wagons barrels of pitch weighing four hundredweight." In May, 1933, I exhibited this patient at the Annual Meeting of the Association of Surgeons of Great Britain and Ireland when he appeared to be in perfect health; in reply to a recent inquiry as to his present state, he writes: "I have not had a day's illness since recovering from the operation, and am as fit as a fiddle." He is now aged fifty-two and is still employed by the same firm, but has risen to be foreman of a department.

## ACUTE EMPYEMA IN CHILDREN

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OF NEW YORK, N. Y.

FROM THE CHILDREN'S SURGICAL SERVICE OF BELLEVUE, WILLARD PARKER AND THE KNICKERBOCKER HOSPITALS

ACUTE empyema in children presents a varied picture from year to year, depending, as it does, on so many factors: the individual patient, the infecting organism, its virulence, the nature and extent of the primary respiratory disease, and most of all, the accompanying complications.

Nowhere is this latter aspect better illustrated than at Willard Parker Hospital, where even the respiratory infection might be considered a complication of some acute infectious disease of childhood. This is also true of the Children's Surgical Service at Bellevue and Knickerbocker Hospitals, where I have had an unusual opportunity to observe the complicated course of suppurative pleurisy in all its manifestations.

In 1924 I reported a series of 154 cases of empyema in children. An outline of treatment which was followed on the children's surgical service at Bellevue Hospital was presented. I am still using the same type of operation. Briefly, this consists of an intercostal incision with the introduction of a "flapper tube." This constitutes a closed type of drainage without the elaborate plumbing system that is frequently advocated. The only change that has been made is, the valve or "flapper tube" is equipped with a very thin rubber finger cot instead of the glove finger then advocated. Irrigations with Dakin's solution or any other chemical or dye stuff has been carefully avoided. The Wolf bottle has also been discontinued since it is quite evident that increasing the intrapulmonic pressure by the use of a blow bottle only causes a temporary expansion of the lung and has little or no value in the ultimate lung expansion which is produced by the healing of the empyema. I am not a stickler for any particular type of operation or drainage. Of the several well-recognized operations and drainage apparatus for empyema, the best one for any given surgeon is the one he is the most accustomed to using, for they were all devised to drain the pleural cavity. Admittedly, they will all succeed if vigilance is practiced post-operatively to keep the tube from plugging. But the less elaborate the apparatus, the more simple and the more fool-proof the drainage becomes.

It has often been pointed out that an empyema operation is not an emergency. I reiterate only because of its extreme importance. It is a difficult problem to decide just when to operate. It must be delayed until the pneumonia has subsided, pleural adhesions have formed and the mediastinum has become stabilized. But, it must not be delayed beyond this point, as these patients are intoxicated by the pleural abscess, and delay only causes more intoxication and frequently converts a good operative risk into a poor one.

The recent literature on empyema is very voluminous. It is mostly devoted to treatment, undoubtedly due to the fact that most cases are first seen by the internist and are then presented to the surgeon when fully developed. Although late on the scene, and at times with fatal complications well advanced, it behooves him to save by operation as many lives as possible. It is conceded that any of the well-developed operations will succeed in a large percentage of the cases, and when the mortality rate is computed from a large series over a number of years from both the closed and open methods, it will be found practically the same. Heuer recently brought this out forcefully by contrasting his Johns Hopkins and Cincinnati series, where open and closed methods were respectively employed.

The cases which I am now reporting are drawn from three sources: the Children's Surgical Service at Bellevue, Willard Parker and Knickerbocker Hospitals, a total number of 265. In this series there is a large number of complicated cases which I wish to especially discuss.

With few exceptions, these cases followed primary respiratory infection, *viz.*, broncho- and lobar pneumonia, and as such are complications of the original disease. For our purpose they may be divided into the pneumococcic and the streptococcic groups.

I have had an excellent opportunity to study both these groups. In the Bellevue and Knickerbocker Hospital series, a large percentage were of the pneumococcic group, while those from Willard Parker Hospital were, with few exceptions, of the streptococcic group. There is notably a difference in these two groups in their clinical manifestations, their pathology, and their mortality, but each differs in severity from year to year and indeed, in different seasons of the same year. February and March have the greatest mortality, but not necessarily the greatest number of cases. The mortality rate gradually diminishes, and in July and August we very seldom see a death from acute empyema. Southern clinics invariably report a lower mortality rate, showing a climatic influence.

As a group, streptococcic cases presented more distressing symptoms. The severity of an individual case, however, cannot be prognosticated from the laboratory report. Illustrative of this, Case No. 390, a boy three years old, W. P. H. series, admitted with pertussis, developed a bronchopneumonia complicated by a right hæmolytic streptococcus empyema. Sixteen days after admission 110 cubic centimetres of thin pus, and three days later 200 cubic centimetres of thick pus was aspirated. He then developed a bronchopleural fistula, coughed up pus for a few days, the temperature slowly subsided and he was discharged from the hospital and remained cured. In this case, although the respiratory infection was a hæmolytic streptococcus bronchopneumonia, the pneumonia was not severe and the complication was a well-localized pleural abscess.

Similarly, Case No. 3924, W. P. H. series, a boy, one year old, admitted with measles and acute otitis media, developed bronchopneumonia, complicated by hæmolytic streptococcic empyema. He was aspirated and only 10 cubic centimetres of thick green pus removed. Aspiration on the third and sixth days gave negative results. He was discharged and without further treatment remained cured.

Quite different is Case No. 3208, W. P. H. series, a girl, three years of age, admitted July 7, 1931, with bronchopneumonia following measles. Four days after admis-



## ACUTE EMPYEMA IN CHILDREN

sion, purulent fluid was aspirated from the left chest. She rapidly became worse and died eight days after admission. She was still in the formative stage of empyema and therefore was not operated upon. Post-mortem examination revealed 150 cubic centimetres of thick greenish pus in the peritoneal cavity with a generalized peritonitis of extraperitoneal origin. There was no evidence of transdiaphragmatic infection from the left pleural cavity which contained 500 cubic centimetres of the same purulent material. The left lung was collapsed and on section showed an old pneumonia. The right lung showed a pneumonic process in each of the three lobes; there was also a purulent pericarditis. Streptococci were recovered from the blood, pleural, peritoneal and pericardial cavities.

Case No. 149, W. P. H. series, a boy of twenty months, admitted January 12, 1931, with scarlet fever, developed bilateral bronchopneumonia. Four days after admission a right pleural effusion was demonstrated clinically and by X-ray which also showed glandular enlargement at the hilum of the right lung. Purulent fluid was aspirated from the right chest on the seventh and ninth days after admission. Both blood culture and chest fluid revealed hæmolytic streptococci. This patient became rapidly worse and died on the twelfth day. This was also a case in the synpneumonic stage and not operated upon. Post-mortem examination revealed 400 cubic centimetres thin pus in the right pleural cavity; acutely inflamed pleural surfaces covered with a thick fibrinopurulent exudate, inflammation of all mediastinal structures which were infiltrated with a cloudy hæmorrhagic exudate. The œsophagus was eroded on its posterior surface. The pericardial cavity was negative. The peritoneal cavity contained 400 cubic centimetres of the same yellowish pus with a generalized fibrinous peritonitis of an extraperitoneal origin. It is interesting to note that there were no clinical manifestations of peritonitis. Pathological diagnosis in this case was streptococcal septicæmia, lymphadenitis, right empyema, mediastinitis, erosion of the œsophagus, acute splenitis, acute suppurative peritonitis, and bilateral confluent bronchopneumonia.

These cases illustrate the extremes in streptococcal respiratory infections. Certainly the streptococcus presents a fascinating uncertainty in its methods of attack.

The treatment of these complicated cases of empyema, as aptly stated by Heuer, "resolves itself into an attack upon the least dangerous condition with the purpose of lessening the load of infection which the individual is carrying." This is well illustrated by Case No. 1960, W. P. H. series, a boy five years old, admitted to the hospital with scarlet fever, following an attack of measles. He developed bilateral bronchopneumonia with marked adenopathy of the mediastinal glands. Fluid developed in the left pleural cavity, from which streptococcus hæmolyticus was isolated. The same germ was isolated from the blood-stream. This patient was kept in an oxygen tent, was given frequent citrated blood transfusions without removing him from his tent. The massive pleural effusion was aspirated at frequent intervals, without producing a pneumothorax. He was not subjected to an operative procedure until blood cultures were negative and the activity of the pneumonia had abated. The simplest form of intercostal drainage with a flapper tube was then instituted. This drainage, though not entirely satisfactory, was sufficiently good to relieve him of the most distressing symptoms. Eventually a rib resection was done. He had a long convalescence but finally recovered.

While the hæmolytic streptococcus is usually the offending organism in these complicated cases, the *Streptococcus viridans* which one usually considers much less ferocious is not infrequently just as potent in the production of pathology.

Case No. 18443, a colored girl of five years, had been treated elsewhere for a very severe pneumonia. She was then admitted six weeks later to the pædiatric service, Bellevue Hospital, July 19, 1932, with a left empyema thoracis; 450 cubic centimetres of thick pus was at once aspirated, and a simple intercostal thoracotomy was done the following day. Her empyema drained satisfactorily, her temperature subsided and she was apparently recovering when, ten days after her thoracotomy, she developed a Jacksonian epileptic attack and, diagnosed as a brain abscess, was subsequently operated upon by the neurosurgical service. Death followed thirty-two days after the convulsive seizure.

# JOHN VERNE BOHRER

Autopsy showed a left pleural cavity completely obliterated by adhesions (empyema was cured) and a large brain abscess which had been drained. Culture from both chest and brain showed *Streptococcus viridans*. This child died of her brain abscess and not of her empyema. It is interesting to speculate on the mode of development of this abscess.

Nor is the pneumococcus wanting in its ability to cause complicated pathology as is demonstrated by Case No. 4702, an infant one year old, admitted to Willard Parker Hospital, September 17, 1932. She had had pertussis for one month and when admitted was found to have a confluent bronchopneumonia. Thoracentesis of left pleural cavity yielded 60 cubic centimetres on the seventh day of thin purulent fluid, and 10 cubic centimetres of cloudy fluid on the tenth day. A double myringotomy was also performed on the tenth day. Three succeeding chest aspirations were made during the ensuing week; on the sixteenth day the patient showed internal strabismus and spasmodic tic of the eyelids. A spinal tap revealed cloudy spinal fluid which showed diplococci on smear. This patient died sixteen days after admission to the hospital. Post-mortem examination revealed a pericarditis, a left serofibrinous pleurisy, a mediastinitis, pericarditis, cerebrospinal meningitis, a suppurative pleurisy, bronchopneumonia, toxic hepatitis, toxic nephritis and bilateral otitis media with the pneumococcus as the causative agent. It is obvious from the above findings that a knowledge of the infecting organism is not always of prognostic value. We find, however, that in a large series of cases of these rapidly developing, non-localizing, deadly types of infections, in which the empyema is only a part of the complicated picture, the *Streptococcus hemolyticus* is the usual infecting organism.

Of the twenty-one deaths in the Willard Parker Hospital series, nine post-mortem examinations were made; in each instance multiple lesions were found. The remainder all gave clinical manifestations of serious complications in conjunction with the empyema. So one might go on presenting protocols, showing multiple lesions in these so-called empyema deaths.

TABLE I  
WILLARD PARKER HOSPITAL

Year	Total	Living	Dead	Per Cent. Mortality	1 Yr. and Under Living	Dead	2 Years Living	Dead
1927.....	7	5	2	28	1			2
1928.....	7	6	1	14			1	1
1929.....	6	3	3	50		2		
1930.....	17	12	5	29	1	3	1	1
1931.....	21	13	8	38	1		3	5
1932.....	20	18	2	10	2	1	4	
	78	57	21	25 plus	5	6	9	9

The mortality rate in the Willard Parker Hospital series is essentially higher than in a non-contagious hospital, because (1) the pneumonia is in reality a complication of the primary disease, (2) all cases that developed fluid in the chest from which organisms were cultured are included. (Many of the complicated cases of polyserous infections would normally have remained on the medical ward, and not be included in a surgical series.) (3) Of the seventy-eight cases, the *Streptococcus hemolyticus* was isolated in forty-six cases. It also occurred in combination with pneumococcus on three occasions and *Streptococcus viridans* once. This preponderance of the

## ACUTE EMPYEMA IN CHILDREN

streptococcus infection, with its tendency not to localize, is a very great factor influencing mortality rate. In the Willard Parker Hospital series the general mortality rate was 26 per cent. in children up to twelve years of age. There were eleven infants under one year of age, five lived and six died.

With few exceptions, the Willard Parker Hospital cases were more acutely ill and of those who survived the morbidity was greater and convalescence more protracted.

Otitis media was a very common complication, occurring twenty-eight times in the seventy-eight cases. Scarlet fever was the primary disease in thirty-four cases, measles in twenty-six, diphtheria in ten, chicken-pox in five, whooping-cough in three. The mortality rate showed no preponderance in sex, nor did it show any difference with respect to the side involved. Of the twenty-one deaths, fifteen cases, or 70 per cent., the *Streptococcus hemolyticus* was the infecting organism.

In the Bellevue and Knickerbocker Hospital series of 187 cases, the respiratory infection was the primary disease with the exception of an occasional post-operative pneumonia which developed empyema. The percentage of complicated cases was much lower with a resulting lowered mortality. At Bellevue Hospital we have organized our service so that a representative from both the paediatric and children's surgical services has been assigned to the care of children having thoracic diseases. These individuals are in constant contact with each other. The surgeon sees all children with serious pulmonary infections admitted to the wards of the paediatric service and the paediatrician follows and prescribes for those who are transferred to the surgical wards. There are frequent conferences, at which time the diagnosis and care of the individual cases are discussed. We have found that by this method the patient receives better attention for there is actually no transfer of the care of the patient, merely a moving of the individual from the paediatric to the surgical wards.

Dr. Charles Hendee Smith has kindly furnished me with the pneumonia statistics from the children's medical service of Bellevue Hospital. In the years 1928, 1929, 1930 and 1931, 1118 cases of pneumonia of all types were admitted. There was a general mortality of 28 per cent. in 1928; 24 per cent. in 1929; 39 per cent. in 1930, and 32 per cent. in 1931.

Of the total number, 650 were definitely lobar pneumonia with the surprisingly low mortality of 3 per cent. This corresponds very closely to the mortality rate in simple uncomplicated empyema.

The remaining 468 cases include bronchopneumonia, terminal pneumonia and pneumonias complicated with other pathological lesions. The general mortality in this group for the four years was 71 per cent. The greatest mortality being in 1930 when 119 cases of this type were admitted with a mortality of 88 per cent. Nearly all of these were complicated cases (empyema or meningitis or in very young infants).

In general, the mortality statistics of pneumonia and empyema follow the same curve. There is one striking divergence for our 1930 cases. There

## JOHN VERNE BOHRER

were 268 pneumonias with a mortality of 39 per cent., only twelve of these cases were transferred to the surgical ward for empyema and all recovered. The explanation must be that in the group other than the simple lobar pneumonia, the complications were so severe that few cases came to the surgical ward, and that the twelve that were transferred were from the lobar-pneumonia group.

This leads me to make the statement that general mortality of empyema usually expressed as the direct result of some special form of surgical treatment may be very misleading. To reiterate, the mortality is more dependent upon the complications of the respiratory disease than upon the particular type of surgical treatment, providing, of course, that well-recognized surgical principles dealing with empyema are not disregarded.

My 1924 report was based on 154 cases of empyema in children treated on the children's surgical service, Bellevue Hospital in the previous five years. By adding these to the present series of 187 cases, we have 241 cases of empyema in children up to the age of twelve, with a general mortality of 15 per cent. (Willard Parker Hospital series not included.)

TABLE II  
KNICKERBOCKER AND BELLEVUE HOSPITALS

Year	Total	Living	Dead	Per Cent. Mortality	1 Yr. and Under		2 Years	
					Living	Dead	Living	Dead
1925.....	24	21	3	12.5		1	6	2
1926.....	17	11	6	35	1	2	6	2
1927.....	14	13	1	7	2		3	
1928.....	45	38	7	15.5	4	2	9	3
1929.....	16	13	3	18	2	2	2	
1930.....	16	16					4	
1931.....	33	30	3	9	3	1	4	1
1932.....	22	19	3	13.5	1	1	1	1
	187	161	26	13.9	13	9-40%	35	9-28%

From Table II we see the variation from year to year in the number and also the severity of the empyemas. In 1925 there was a moderate number with a moderate mortality. In 1926 there were fewer cases, but the highest mortality of the series. The only death which occurred in 1927 was at Knickerbocker Hospital (the only death in the Knickerbocker Hospital group). Likewise there was a small number in 1930 with no mortality; 1929, 1931 and 1932 are average years in number and severity.

In the present series there were sixteen cases treated by aspiration only, with a mortality of 31 per cent. This included those in the formative stage, which died before operation was indicated.

Simple intercostal thoracotomy was done 167 times (including six bilateral cases). Primary rib resections in fourteen cases. Secondary operation for unsatisfactory drainage was performed in twenty cases; it usually consisted of making a long intercostal incision, introducing Lilienthal rib spread-

## ACUTE EMPYEMA IN CHILDREN

ers, and thoroughly exploring the pleural cavity. There was no mortality from these secondary operations.

From clinical observations and post-mortem findings, I can state that if empyema cases are managed by a modern form of treatment, which consists of supportive treatment with aspiration if necessary during the formative period of the empyema, followed by efficient drainage when the pneumonia has subsided and pleural adhesions have formed, the mortality from simple empyema in children above two years of age is practically nil.

The mortality in infants, even in uncomplicated empyema, is still far too high. In this series (Bellevue and Knickerbocker Hospitals), infants under one year of age showed a mortality of 40 per cent., under two years of age 28 per cent. This infant mortality is very discouraging. It varies widely in different years. In 1927 and 1930 there was no mortality. In fact there was no mortality for eighteen months. During such a period of "luck" one is inclined to give too much credit to the operative treatment. This fallacy will be discovered subsequently when the mortality again rises in succeeding years even with the same kind of treatment.

The solution lies in closer coöperation between the pædiatrician, who is able to properly feed these sick babies, and the surgeon, who must do a minor operation, avoiding all irritating tubes and dressings. The presence of even a small drainage tube between an infant's ribs causes sufficient nervous irritability to make it refuse food or to regurgitate when forced to take it.

The plan I have followed in the last eighteen months is to make a simple intercostal incision over the involved area, allowing pus and fibrin plugs to escape, while a small hæmostat is held in the wound, no drainage tube of any kind being inserted. On the second or third day it may be necessary to reinsert the hæmostat, and evacuate what has re-accumulated. This will at least carry the case over a critical period when more adequate drainage may be instituted.

Case No. 2013, a boy ten months of age, was treated in this manner and survived a bilateral empyema. Case No. 2953, a girl eight months of age, developed scarlet fever, pneumonia and a right empyema. She was very ill at the time of operation, and the above procedure proved very satisfactory.

In connection with the post-operative care of these infants, it must be recognized that they have a very low vital capacity, and will therefore not withstand an open pneumothorax. They must be treated by aspiration until the surgeon is satisfied that pleural adhesions have formed and no collapse will follow thoracotomy. Body heat must also be carefully maintained. Oxygen therapy is of great value if there is a further complicating pneumonia. High caloric diet must be given and fluid forced by hypodermoclysis if necessary. Blood transfusions are imperative.

If we group reported cases by age, we find that the mortality among those under two years is from 15 to 45 per cent. In my series there were sixty-six cases with a mortality of 27 per cent. Twenty-two cases were under one year with nine deaths. Between the ages of two and six years,



the number of deaths materially decreased, and from six to twelve it was reduced to 2 per cent.

These findings are not unlike those of other types of surgical infections which occur during the period of childhood. For example, in acute appendicitis the mortality in children under two years of age is from 30 to 40 per cent. and drops to 4 or 5 per cent. in the second half of the first decade.

Analyzing our cases from the standpoint of infecting organisms, forty-one cases are grouped together composed of rare organisms, no growth, and no report; in this group seven died. Of the 146 cases in the classified group, eighty cases followed lobar pneumonia and were due to the pneumococcus, in this group the mortality was  $7\frac{1}{2}$  per cent.; thirty-four cases were caused by the streptococcus, the mortality for the entire streptococcus group was 15 per cent. (twenty-five cases were due to the hæmolizing streptococcus with only one death; five to the non-hæmolizing streptococcus, with two deaths; four to the *Streptococcus viridans* with two deaths). The *Staphylococcus aureus* was found in 12 per cent. and death followed in 16 per cent. A mixed infection, commonly streptococcus and pneumococcus, or streptococcus and staphylococcus occurred in 7 per cent. In this group, the mortality was the highest, namely, 45 per cent. Organisms tabulated in order of their gravity in this series are the following: Mixed infections, staphylococcus, streptococcus, pneumococcus.

In summarizing these facts, it may be stated that pneumococcus empyema is an end-product of a lobar pneumonia and usually when discovered the activity of the pneumonic process has ceased and there is a simple empyema which has walled itself off with a fibrinous exudate and adhesions. This is a simple matter to deal with. Empyema due to the streptococcus is an accompanying condition rather than a complication of the inflammation of the lungs and is often further complicated by other lesions of a metastatic nature which are as grave, if not more so, than the empyema. The lesion does not tend to localize and the mediastinum remains unstable and flexible. A septicæmia is frequently present in streptococcus cases which adds greatly to the severity of the case.

Empyema due to the staphylococcus is often the result of a lung abscess, or multiple subpleural abscesses, in itself a serious condition, and accounts for the unexpected high mortality in staphylococcus cases in this series.

The prognosis to be made in a given case of empyema must be based upon several factors: first, the age of the child; second, the type of infection; third, the virulence of the infection which can be judged only from experience of recent cases of the same type; fourth, the character of the complications or accompanying lesions that may be present, especially the presence of persisting pneumonia, and fifth, the general condition of the patient.

*Aspiration.*—There seems to be considerable difference of opinion on the advisability of aspiration. Some surgeons state that a case of empyema should never be operated on if pus cannot be found by aspiration. Others

## ACUTE EMPYEMA IN CHILDREN

believe aspiration a dangerous procedure and advise against it even as a diagnostic means.

In this series all cases have been aspirated both for diagnosis and as a preliminary treatment during the formative stage of the empyema. I have observed no complication traceable to this procedure. Admittedly, it must be carefully done, the needle must not pass through the abscess into the lung tissue or into a pulmonary vessel. I believe a brain abscess can be caused by direct introduction of infection into the pulmonary circulation by accidentally introducing the needle into a vein. I have recently seen a case develop a brain abscess following an exploratory aspiration where blood was aspirated. It was, of course, not proven as the causative factor of the brain abscess, but certainly it was very suggestive. Similarly, the frequency of brain abscess in long-standing cases of bronchiectasis or lung abscess, with erosion of vessels and hæmoptysis, leads me to believe that infection introduced directly into a pulmonary vein is provocative of a brain abscess.

As a curative measure, it can be applicable to but few cases. There are, of course, always a few cases in every series that have been cured by aspiration alone. Aspiration with air replacement, as described by Danna, certainly merits investigation. I have tried a few cases without success, but possibly this was due to non-persistence.

One should certainly not hesitate to operate on a case of empyema just because pus cannot be found by aspiration. In most cases of mesial empyema, pus is not found with an aspirating needle, yet there may be many signs of fluid in the chest. This is illustrated by Case No. 109 (Willard Parker Hospital series), a girl of four years, who had scarlet fever followed by bronchopneumonia. Her pneumonia had abated, but the temperature continued. The usual signs of flatness and distant breathing could not be elicited. The X-ray pictures, however, demonstrated a marked pleural thickening. Repeated aspirations by various members of the staff were negative. Exploratory thoracotomy revealed a large pocket of pus between the lung and the mediastinum.

*Bilateral Empyema.*—In this series there were six cases of bilateral empyema with one death. In general the mortality in bilateral empyema is controlled by the same factors as in unilateral, *viz.*, the age of the child and type of infection, and most of all the type of pneumonia. These six cases were treated by the usual procedure of a simple thoracotomy with flapper tube drainage. They were operated on with one- or two-day intervals between sides. No difficulties were encountered. The youngest bilateral case was ten months of age. It survived.

*Transdiaphragmatic Infections* occurred twice in this series. First case, a boy of six years, Bellevue Hospital series, was operated upon for an acute suppurative appendicitis; he developed a pelvic cellulitis which disappeared spontaneously. He also developed a subdiaphragmatic abscess which penetrated the diaphragm and then ruptured into a bronchus. Drainage of the

subdiaphragmatic space stopped the drainage through the bronchus. The patient recovered.

Second case, a boy of ten years, Willard Parker Hospital series, operated on for acute gangrenous appendicitis, subsequently developed a subdiaphragmatic abscess, which involved the supradiaphragmatic area. This abscess was drained through the pleural cavity, with recovery. In both cases the infection apparently was by direct extension.

One case only of transdiaphragmatic infection from pleural cavity to peritoneum by lymphatic drainage occurred. Case No. 4793, a girl of five years, operated on for left empyema. She had a long and stormy course of staphylococcic pleural suppuration. When all but cured of her empyema, gastro-intestinal symptoms of a severe nature developed. Autopsy revealed a gastroenteritis; suppurative retroperitoneal nodes and a localized peritonitis.

*Empyema plus Septicæmia.*—The exact frequency of this complication has not been determined for this series. That it occurs more frequently than suspected has been demonstrated by recent findings since we have been doing routine blood cultures on all empyema cases. Again one must differentiate between transient bacteræmias and real septicæmias.

Little is to be found in the literature concerning this complication. Heuer states that the mortality in his series was 100 per cent. In this series there were fourteen proven cases. Of these, six lived and eight died, a mortality of 57 per cent. The six who survived did not have metastatic abscesses, but their empyemas were universally of long duration with pocketing and frequent reinfections, even after the empyema was healed these patients had a slow convalescence. The eight deaths are all classified in the complicated group. Six had autopsies and showed one or more metastatic lesions such as pericarditis, peritonitis, lung or brain abscess. All others had clinical manifestations of the same type of metastatic lesions.

*Chronic Empyema*, in this series, is conspicuous by its absence. It has practically disappeared, due, I believe, to the better post-operative care received by acute empyema cases. In the earlier periods, many empyema cases were hospitalized for only a short period. They were sent home to return to the out-patient's clinic for dressings. Most of the chronic empyemas resulted from this practice. No one individual was responsible for their treatment; as a result pocketing was not recognized, osteomyelitis of a rib often kept the sinus discharging, while poor home sanitation caused repeated respiratory infections, frequently reinfecting the pleural cavity.

Where a tubercular infection has been superimposed, healing of the sinus is slow, but these cases should not be classified as chronic empyema. At present, our routine is that no patient is discharged until the wound has been healed for at least ten days. As a result there have been very few readmissions, only an occasional one for an abscess formation from sequestration of a small portion of rib.

*Healing of Acute Empyema.*—It is axiomatic that complete expansion of the lung is necessary for complete cure of an empyema. There are cases where the chest wound closes leaving an apparent sterile pneumothorax, but

## ACUTE EMPYEMA IN CHILDREN

such cases should not be classified as cured. They may become active even years after, if the lung does not eventually expand and obliterate the cavity.

The question naturally arises, how does an empyema heal? Or what causes the lung to expand? In a normal chest two factors play a prominent rôle in lung expansion, *viz.*: positive intrapulmonary pressure and negative intrapleural pressure. That positive intrapulmonary pressure will make a post-empyema lung expand is easily demonstrated. If one decorticates a lung that is bound down by thickened pleura, then causes the patient to take deep inspirations, the lung will readily expand to its full capacity and fill the pleural cavity, but it will not remain so, even though the chest is closed when the lung is completely expanded. So, too, if you observe with the fluoroscope the movement of a partially expanded lung as the patient increases the intrapulmonary pressure. The lung will expand but immediately drop back to its previous position when the increased intrapulmonic pressure is released. It is quite evident that the blow bottle, though it has been used for many years, plays but a small part, if any, in causing the lung to expand. The production and maintenance of a normal or increased negative intrapleural pressure is just as barren of results.

How then does expansion occur? The answer is readily seen by the autopsy of a recently cured empyema. The findings are a complete obliteration of that portion of the pleural cavity that was previously the site of the empyema. This process can be observed from its beginning, if the Connor operation for empyema is used.

In this operation where a goodly sized wound is made in the chest-wall by resection of portions of two ribs and the empyema cavity packed with gauze, if careful observations are made, you can see the granulation tissue on the parietal and visceral surfaces gradually united and it is this healing together, just as the edges of a superficial wound heal, that ultimately pulls the lung up to the chest-wall. The same thing can be observed by watching the lung expand in a pneumothorax. The lung creeps along the periphery of the chest-wall, until it completely obliterates the cavity. Case No. 2098 a girl, five years old, illustrates the latter process. She developed an empyema, with a bronchopleural fistula with 75 per cent. collapse of her lung. There were some adhesions to the diaphragm. The drainage sinus closed and remained closed before the lung expanded. Gradually the lung moved out across the diaphragm to the costodiaphragmatic angle and from there it rapidly became adherent to the parietal chest-wall and complete expansion slowly took place.

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JOHN VERNE BOHRER

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## CONTRIBUTION TO THE DIAGNOSIS AND TREATMENT OF HYDATID CYSTS OF THE LUNG

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HYDATID cysts of the lung are rather frequent in Greece. Thus of the 114 hydatid cysts that we have operated upon since 1927 up to the present there were twenty-nine cases of hydatid cysts of the lung, sixty-eight cases of hydatid cysts of the liver, three cases of hydatid cysts of the spleen, and the rest in various other parts of the body, *i.e.*, the proportion of the hydatid cysts of the lung has been 23 per cent. of hydatid cysts in general.

Our statistics show also that the cysts are more frequent in the provinces than in the capital of Greece (one in seventeen cases), and we are of the opinion that this is due to the better organization of the abattoirs in Athens and the domestic life of the Athenians than to the agricultural life of the provinces.

Owing to the frequency of the cysts in Greece, the question of the diagnosis and treatment of this disease has often been discussed by various scientific societies. Thus, the question of the treatment of the hydatids of the lung has actually arrived at a satisfactory solution, and we may thus attain frequent cures with a minimum rate of mortality.

With the aid of radiography, radioscopy, and other biological proceedings, it is not very difficult to make the diagnosis of hydatid cysts. From a clinical point of view, examining a patient of more or less good health, we find cough, often irritative, blood spitting or expectoration, sanguinary or not. Usually we do not find the prodromes of consumption, nor the facies that this disease gives to the consumptive. On the contrary, there is nothing previously which might lead us to suppose a pre-consumptive condition. The cystic disease with all its symptoms installs itself in the midst of perfect health. In the cases of unbroken cysts with aseptic contents, the clinical examination always reveals a dulness at the level of the cyst, and a more or less sharp diminution of the vesicular murmur. Aside from certain friction sounds which are not always heard, we do not hear any râles, nor other symptoms of a cavity as in cases of diseases which destroy the pulmonary parenchyma, but sometimes we hear some deep clamorous râles around the dulness, due to a congestion of the pulmonary parenchyma which occur near the tumor. The patient having such a cyst has no fever, but sometimes presents some sanguinary or mucopurulent sputa which come after an attack of cough.

In the cases of cysts of septic contents a rather high fever, 39°-40° C. appears, often suddenly, which may make one attribute these phenomena to

a bronchopneumonia of grippal origin, and this is the more so because the patient presents at the level and about the cyst the phenomenon of a pulmonary congestion which is shown by clamorous râles, and by a very abundant mucopurulent or sanguinary expectoration which begins at the very moment at which the general phenomena appear. But in this case also, a skillful physician can find a subdulness or a dulness at a part of the hemithorax infected by the cyst with a diminution of the vesicular murmur, without suppression of the vibrations which can be attributed neither to an abscess of the lung, nor to a local pleuritical effusion, due to the sudden and abrupt appearance of these local phenomena. But it happens that this cystic suppuration causes a reaction of the part near the pleura, and consequently a pleuritical effusion. In this case, the objective and subjective symptoms of the pleurisy shall predominate, and in such case it might be impossible to make the diagnosis of the origin of this pleurisy unless the patient had previously presented the precise phenomena of the existence of the cyst (vomit containing fragments of cysts, or clear liquid).

When the cyst is aseptic and broken, and this rupture had caused a vomit of clear liquid with fragments of cyst, the diagnosis is evident. But when the cyst is septic and broken, the purulent vomit does not indicate the existence of a cyst but only when there are fragments of cyst in the pus.

The finding of hooklets in this vomit uniquely purulent, as well as in the expectoration, occurred rarely. Therefore one cannot make the diagnosis of the existence of a cyst only by this uniquely purulent vomit, because there may be either an abscess of the lung or an interlobular pleurisy, the rupture of which into the bronchi caused the appearance of the vomit.

Finally, urticarial eruptions are sometimes met with in patients suffering from hydatid cysts.

The various biological examinations largely contribute to the solution of the problem of the diagnosis. The examination of the blood often reveals an increase of the eosinophiles, but we know that this increase may also be produced in other parasitical diseases, and the diagnosis of the cyst cannot be founded upon this examination only.

There is also the serodiagnostic according to the proceeding of Weinberg, but, as we have already said in an article published in the *Journal de Chirurgie de Paris* of April, 1931, No. 4, this reaction, in most of the cases, proved to be disappointing and, consequently, the results of same are not very certain.

Casoni's cuti-reaction gave much more certain and constant results, especially in the cases of nonsuppurative hydatid cysts. Sometimes in the suppurative hydatid cysts, the suppuration of which dates from a certain time, Casoni's cuti-reaction was negative. But in the greater number of cases it was positive. Thus in our twenty-nine cases, Casoni's reaction was made sixteen times, and it was twelve times positive and four negative. In these twelve cases (positive) three concerned suppurative cysts; and out of the four negative three concerned also suppurative cysts.

## HYDATID CYSTS OF THE LUNG

Radiography, finally, gives important and sufficiently precise information. The radioscopical or radiographical image reveals the existence of a shadow at the level of the lung, of a usually spheric shape, and of net contours. The image of the pulmonary parenchyma surrounding the cyst is of clear appearance. Sometimes, however, the contours are not very clear but slightly unclear, and this is due to the reaction of the environing parenchyma. The shadow is homogeneous, *i.e.*, it does not present clearer or darker spots, except when the cyst is broken. In this last case, the existence of gases in the interior of the cyst gives an image absolutely particular (Fig. 1) hydro-airy.\*

Ordinarily, there is but one cyst in the lung; seldom more than one cyst is to be found in the same lung. In our statistics we have revealed the existence of two cysts in only one case. (Case XXVI; see also Fig. 3.)

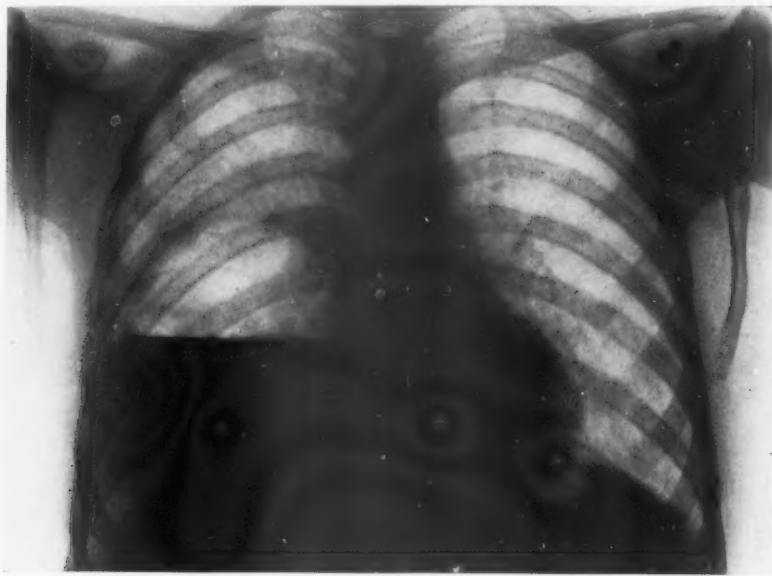


FIG. 1.—Hydatid cyst of the right lung broken into the bronchi-hydro-airy image.

These radiographical results, in the course of the clinical examination, together with the biological examinations, can give very often precise solution of the problem of diagnosis. In spite of this, however, there are cases where it is very difficult to make the diagnosis, and one might be deceived and confound this disease with other pulmonary pathological conditions. Among these conditions come in the first place *sarcomata* of the lung primitive or metastatic, then comes the *circumscriptive form* and the *modular form* of cancer of the lung which may give a shadow of clear contours, and finally dermoid cysts, and the neurofibromata of the mesothorax. (Rare cases.) Beulot et Peuteuil published in the *Journal de Radiologie de Paris* (vol. xiv,

\* This description of the radiographical image of the cyst was given by Beclere thirty-five years ago. Beclere described at that time "the circular image as drawn by the compass, of very clear contours."

1930) clichés of such neoplastic formations which were not hydatid cysts. We also made this wrong diagnosis in two cases of pulmonary sarcoma which we had taken for hydatid cysts. These cases are the following:

CASE I.—V. P., man, aged forty-five, from Aegina, entered the hospital December 17, 1930, with the history that eight months previously, without any other antecedents, and in perfect health, he was seized by an irritative cough. This cough was repeated rather often and was not accompanied by expectoration. For six months, besides these crises, he presented sanguinary spittles and fever that went up to  $38.3^{\circ}$  at night. His general condition was satisfactory. When he entered the hospital, temperature was  $37.8^{\circ}$ . Examination of the thorax revealed dulness and a diminution of the vesicular murmur at the level of the right scapular region, as well as in the corresponding axilla; the anterior face of the thorax, a very slight diminution of the vesicular murmur. No diminution of the vibrations. Urine, normal. White corpuscles, 10,500. Eosinophiles, 6 per cent. Casoni, negative. Sputum: no hooklets, no Koch's bacillus. Radiography showed a spherical shadow, of clear contours, at the level of the superior lobe of the right lung. Half of this shadow was confounded with the shadow of the arch of the aorta. This shadow was not homogeneous but it showed clear opaque parts. (See radiographical plates.) A diagnosis of suppurative hydatid cyst of the superior lobe of the right lung was made.

Operation, December 20, under local anaesthesia, an incision was made on the posterior face of the thorax between the internal border of the scapula and the spine at the height of the fifth intercostal space. Resection of a part of the fourth rib, followed by section of the scapula outside and upward, and the division of pleuropulmonary adhesions made possible the demonstration of a pulmonary tumor at this level. Puncture of this tumor did not give any liquid, but produced the impression of going through hard tissue. Further incision of the pleura and the lung exposed the tumor, a part of which was removed for histological examination, which demonstrated it to be a sarcoma of the lung (Prof. Katsaras), for which a radiotherapeutic treatment was prescribed.

CASE II.—S. N., man, aged seventy-three, from Lamia, entered hospital August 11, 1933, with the history that five months before he had been seized by a local pain at the level of the anterior face of the right hemothorax, accompanied with fever up to  $39^{\circ}$  to  $40^{\circ}$ , and shivers. The various physicians who examined him made the diagnosis of a pneumonia, but, as these phenomena continued to exist, he decided to enter the hospital. He was rather weak. Behind, as well as in front of the right hemothorax from the top to the middle of the scapula behind and of the fifth space in front, the vesicular murmur was diminished behind, and suppressed in front. Between the two axillary lines nothing abnormal. The rest of the lung normal. No blood spitting. Purulent expectoration. The sputum contains pneumococci. No hooklets. White corpuscles, 14,600. Eosinophiles, 1 per cent. Weinberg, positive. Casoni, slightly positive. The radiograph showed a homogeneous spherical shadow, of the size of an orange at the level of the superior lobe of the right lung. The rest of the lung presented clear arborizations which started from the navel, stretched over the whole lung and extended to the limits of the above-mentioned shadow.

Owing to the sudden appearance of the phenomena, the fever, the increase of white globules, and the positive reaction of Casoni and Weinberg, we were inclined to make the diagnosis of a suppurative cyst of the lung, with reaction of the pulmonary parenchyma, and this was the more so because the patient was a peasant and the Casoni and Weinberg were positive. (We have noticed in two cases of sarcoma that Casoni was positive.)

The radiographical image made us think a little on the nature of the tumor. These rather opaque arborizations which started from the above-mentioned shadow suggested a tumor. Thus, our diagnosis was doubtful between a hydatid cyst and a tumor of the lung.

## HYDATID CYSTS OF THE LUNG

After radioscopical and stereoscopic localization an operation was done August 14, 1933, under local anaesthesia. An incision was made at the level of the fifth intercostal space in front, followed by resection of a part of the fourth rib. Pleuropulmonary adhesions were met with. An incision of the pleura and the lung revealed a sphacelated neoplasm surrounded with a fibrous membrane, in the interior of which existed suppurating cavities. Fragments of this neoplasm were removed by a curette and sent for histological examination.

The patient died twelve days after the operation. The histological examination showed the tumor to be a sarcoma of the lung.

Here are, therefore, two doubtful cases where the clinical examination as well as the radiographical and radioscopical one did not precise the diagnosis.

We said hereabove that the shadow which a cyst makes at the radioscopical and radiographical examination is homogeneous. If one examines well



FIG. 2.—Sarcoma of the lung.

the radiograph of the first patient who has a neoplasm of the lung (Fig. 2), he sees that the shadow is not homogeneous, and that it presents besides the opaque parts spots much clearer, and this is due to the uneven filtration of the pulmonary parenchyma by the neoplasm. As we noticed at the operation the neoplasm is surrounded by a fibrous membrane and between the membrane and the pulmonary parenchyma exists *un plan de clivage* (plane of cleavage). And it is just this membrane which makes the shadow which is seen at the radiography to have clear contours. What has to be noticed in this image is that the shadow is not homogeneous but of uneven opacity which does not happen in the case of a cyst. The cyst gives a homogeneous opacity because it is *always* full of a septic or aseptic liquid, which makes the shadow which is seen at the radiography not to show any unevenness. But when the cyst is broken, this unevenness ceases to exist, being given that there are



gases which penetrate in the cavities. But in such case the radiographical image is absolutely particular and easy to interpret.

In our second case the shadow which was seen was homogeneous in spite of the fact that it was the case of a pulmonary neoplasm. But this was due, we believe, to the suppuration of the neoplasm, which made the pus that filled the three-fourths of the cavity of the tumor created by the sphacelus of the neoplastic tissue to give in the radiographical image the impression of homogeneity. In conclusion and after what we have indicated before, the diagnosis of a hydatid cyst of the lung presents only relative difficulties. Aided by the clinical symptoms, the biological examination, and the radiographical image, this diagnosis should be made in the great majority of the cases, especially in the case of patients living in countries where this disease is frequent. It should also be made so that the patient might be treated in time, and before the complications of septicity or rupture occur, which may sometimes endanger the life of the patient. Before examining the surgical procedure by which a hydatid of the lung should be treated, we believe that we should stop a bit at the question of the localization of this cyst. It is a very important question because it is by a good localization that we will choose the shortest and the least dangerous path to reach the cyst.

We make very often the localization by radioscopy, and after giving a glance to the thorax, we see at which side of the thorax the cyst is nearer.

The radioscopical examination in profile shows us also, not always but rather often, at which side the tumor is nearer to the side of the thorax.

When, thus examining the patient, we have chosen the shortest way, we trace at the side of the thorax, and at that level, two lines in silver nitrate, corresponding to the superior and inferior borders of the cyst.

Also the stereoscopical examination of the tumor gives us very accurate information regarding the localization of the cyst and the path of access that should be chosen.

We have insisted on this chapter of the localization which we consider capital, because if we rely solely upon the simple radiographical examination to attack the tumor, errors might be committed that may not be free from danger. The cyst might be attacked from the front when the tumor is localized at the back, and in such case it will be necessary to traverse an important part of the healthy parenchyma which might cause a bleeding not only sometimes dangerous, but also sometimes mortal.

We attribute the death of our patient of Case XXIII to the bad localization made by one of our assistants. As it is cited in the case report, we were obliged to arrive up to the cyst to traverse six centimetres of parenchyma with our needle. It is true that the death of this patient was not due to a bleeding and it happened while the liquid was drawn out of the pocket of the cyst. For some time we have been against puncture of pulmonary cysts for the reason that we are going to explain further. But in this case, we were obliged to puncture, since after opening the pleura we fell upon a sound part of the lung, and felt nothing particular that could make us think of the

## HYDATID CYSTS OF THE LUNG

existence of a tumor. Had we made a more precise localization, this patient might have been operated upon by an interaxillary incision, and we believe that then we might have fallen just upon the tumor without being obliged to puncture.

The localization and especially the stereoscopical examination are very useful also in case the cyst is central, surrounded by a very thick coating of parenchyma, and this is an indication against the operation, as we will see farther on.

The operation is not necessary, according to our opinion, in the case of central cysts especially situated near the pulmonary navel, unbroken, and which do not cause serious complications, such as dangerous blood spittings, and septic phenomena, as well as in the cases of broken cysts presenting signs of spontaneous cure after vomiting. On the contrary, the operation is required in the case of central cysts causing dangerous bleedings or which, after rupture, are the cause of a manifest aggravation of the general condition, and finally in all the cases, without exception, of cortical cysts.

We said that the operation is not necessary in the cases of calm central cysts. To be more accurate, we must add that the operation is not indicated at the moment of the diagnosis of a central cyst, and in this case we must recommend to the patient to be often examined until the central cyst, by its progressive augmentation, becomes accessible without causing to the patient the danger of a serious operation.

The position that we prefer to give to the patient is half seated, with a slight inclination towards the sound part. When we have to attack the posterior face of the thorax we make use of the position of "the jockey *à cheval*" of Lamas.

We have always used in our cases local anæsthesia, which has given us full satisfaction. We prefer the local anæsthesia to any general anæsthesia because, as we already said, first it is quite sufficient, and second because the local anæsthesia, while we operate, enables the patient to cough and evacuate his bronchi of the contents of the cyst which sometimes penetrate during the operation or the puncture of the cystic tumor. This cough is suppressed during general anæsthesia, and if the quantity of the liquid which penetrates the bronchi is more or less copious, then we may have a suffocation crisis which is difficult to avoid.

The intervention consists of a simple thoracotomy, linear incision of the soft parts with resection of one or two ribs on a space of six to eight centimetres. In a great number of cases, the existence of pleuropulmonary adhesions allowed the opening and evacuation of the cyst at one time, through the adherent pleura.

In our article in the *Journal de Chirurgie de Paris*, 1931, we wrote that the wall of the cyst should be incised after an exploratory puncture. Now we prefer not to puncture but, after a good localization, to incise free and largely the wall of the cyst, to take off rapidly the mother vesicula and dry the cavity. We avoid the puncture because through the hole created in the

mother vesicula by the puncture, the liquid which is found in the interior of the vesicula, under certain pressure, is accumulated, mixed with blood between the mother vesicula, and the adventitia. This last is often present in the bronchial holes. Then the liquid penetrates in the bronchi through these holes and causes a cough which may be very annoying for the patient and the operator. Further, if the bronchial hole is more or less big, and the penetrating liquid mixed with blood is abundant, the patient may present phenomena of asphyxia.

On the other hand, we consider that such penetration of the liquid is very bad, seeing that it may cause very serious anaphylactic phenomena and cause the patient's death on the operating table. We believe that the death of our patient of Case XXIII was due to this cause.

We have never introduced into the cystic cavities solutions containing formalin, as we consider this practice dangerous.

When the depth of the cyst is greater than two centimetres, to incise the parenchyma and open the cyst we make use of either the thermocautery, or rather, of the electric bistoury, a practice which completely avoids bleeding. Thus we have never observed notable bleedings which required tamponing.

When the cyst has been incised, the mother vesicula, we have to repeat, should be removed very rapidly and the cavity should be dried.

The question comes forward now whether the pulmonary parenchyma should be completely sutured or whether it should be drained. Makkas and Geroulanos have lately preconized the complete suture without drainage in the case of aseptic cysts. We have never followed this method of procedure but only once and for the following reasons:

We believe that the interior of the cavity almost always communicates with the bronchi, and the irritative cough and the blood spitting which the patient sometimes presents during the operation are due to this cause. In that case, the cavity which remains should not be considered as an aseptic cavity and is surely subject to suppuration, and it is for that reason that we believe that the drainage is indispensable. Finally, the large dimensions of this cavity, and even the thickness of the adventitia, the bad condition and the lack of elasticity caused by the surrounding pulmonary parenchyma, further the position of this cavity (that of the top having a tendency to remain gaping for a long time owing to the thoracic rigidity)—all these factors make the cavity remain gaping for a long time and therefore subject to infection. Therefore we prefer to partially suture the incised side and apply Geroulanos' procedure (Congrès International de Chirurgie, Bruxelles, 1912) which consists in the provisional drainage of the cavity with the help of a drain of a very small calibre round which the lips of the cavity as well as the parietal plane are hermetically sutured. The free extremity of the drain is closed by a ligature, and thus any communication with the surroundings is completely suspended.

The ablation of the drain in case of normal evolution is effected on the fifth or the sixth day and is followed by a prompt cicatrization. But, on

## HYDATID CYSTS OF THE LUNG

the contrary, if a frank suppuration develops, a systematic drainage is immediately applied.

Absence of pleural adhesions renders the problem rather embarrassing. The operative pneumothorax is not to be feared any longer since we systematically apply it for the treatment of other pulmonary diseases, in a slow and progressive manner, with immediate fixation of the lung by Delageniere's method. In hydatid cysts what is dangerous is the passing into the pleural cavity of the liquid or pus flowing from the cystic cavity. It is true that the secondary pleural echinococcus, or the anaphylactic accidents which might be observed, are not fortunately so frequent as we were inclined to believe. However, these are two dangerous complications, as well as the purulent pleurisy which cannot be avoided in the case of suppurating cysts. The special apparatus such as the hypopression chamber of Sauerbruch and the hyperpression apparatus of Brauer and Meltzer-Auer, are used by certain surgeons in these cases. We believe that these apparatuses cannot render us great services, because the tightness which they produce by the adhesions between the two pleural leaflets is insufficient. Thus, in a great number of our cases we have followed the method in two times recommended and practiced during the last years by the South American authors, Lamas, Mondino, Prat. This method consists of the opening of the pleura, and the introduction between the two pleurae, parietal and pulmonary, of compresses for the production of adhesions. These compresses remain thirteen to fifteen days, and at the end of that period the adhesions are formed, and the second time may be executed, *i.e.*, the opening of the cyst. The pleural reaction which results has never been particularly grave.

This method, however, is not free from inconveniences. The opening of the pleura produces a partial pneumothorax which alters the locus of the lung so that the cyst is not found any longer right opposite to the incision. These inconveniences are not negligible, because as a part of this second step we are obliged to search for the cyst and again resect ribs. In our cases, prior to the execution of the second time, we make a new radioscopy of localization to see if the slight pneumothorax did not move the tumor. Ordinarily, this change of place was minimum. But, sometimes, it was rather important and required the resection of other ribs. To avoid this inconvenience we have tried, instead of applying compresses after the opening of the pleura, to catch the lung and fix it on the side by threads of catgut without incising the pleura. We believe, nevertheless, that this practice is dangerous because if ever our needle meets and traverses the cyst there will be a flow of the liquid into the interior of the pleural cavity. For that reason we have abandoned this method, and in two cases we have applied the process of Baugardner (Cases XXII and XXIV) which consists in the tamponing of the wound caused by the costal resection with "iodoformized" compresses. Baugardner, who applied this method in cases of pulmonary abscesses, said that ten to fifteen days after the above procedure, pleuropulmonary adhesions were formed. In our cases, these adhesions have not

been found. There has been a thickness of the parietal pleura but the underlying lung was completely free of adhesions. We will simply mention the procedure preconized by Sauerbruch, which consists in the establishment of an extrapleural pneumothorax at the height of the cyst with introduction of paraffine in the cavity of detachment. This method, capable of producing adhesions, may permit, owing to this fact, the opening of the cyst at a second time after extracting the paraffine. But the method presents, according to our opinion, the inconvenience of producing a partial but definite collapse of the lung, or otherwise a notable diminution of the respiratory field. We, therefore, are partisans of the above-mentioned procedure of the South American authors in spite of the slight inconveniences as related hereabove.

Recently two surgeons of Athens, Greece—Professor Geroulanos and Doctor Makkas—preconized the operation at one sitting in the case of lack of adhesions (Brun's *Beitrage zur klinischen Chirurgie*, vol. xcii, Nos. 3 and 4, pp. 645-676, 1927). We, also, have treated five cases in this manner (Cases XII, XVII, XVIII, XIX and XXVI). In 1931, we wrote in the *Journal de Chirurgie* that we were inclined to adopt the operation at one sitting for all the cases of hydatid cysts of the lung free of adhesions. We have, however, operated upon a certain number of cysts since that time without employing the procedure in one sitting because we had always the fear of the contamination of the pleura, particularly in the cases of suppurating cysts which are not rare (Cases XVII and XVIII). We have found that the formation of adhesions by the procedure indicated above is a guarantee against the complications after the operation.

On the other hand, the loss of time between the first and the second intervention is so small (thirteen to fifteen days) that it should not be taken into consideration. With a good localization and the formation of adhesions, we are positively sure that the patient will be normally cured. While if we operate at one time, the patient having a cyst suppurating or not, the danger always existed of contaminating the pleura, and in such case we do not know the course which this pleural contamination will take without considering that even in the case of aseptic cysts there is danger of the hydatid vaccination and of the phenomena of anaphylaxy.

This procedure might, however, be applied in the case of cortical cysts which almost touch the pulmonary envelope or which may even surpass it. In such case, the pleura may be freely incised, the pulmonary parenchyma environing the cyst caught by forceps, and the lung brought towards the parietal wound. Then the cyst, which is very apparent, appears at the incision, and we may then fix the parenchyma held by the forceps by points of catgut, and then incise the cyst without danger. This procedure, however, remains the only recourse for the patient who has a central cyst or a cyst situated near the navel which causes serious phenomena as, for example, repeated and abundant spitting of blood or phenomena of a serious infection.

Finally, we may mention the operative cure of a hydatid cyst at the base of the lung, after phrenicectomy. A patient, whom we had not examined



## HYDATID CYSTS OF THE LUNG

before the operation, was sent to us with the diagnosis of a cavity at the base. Some time after the phrenicectomy this patient while vomiting evacuated the contents of his cyst. We do not intend at all to practice as an ordinary operative method the extraction of the "phrenic" in the case of hydatid cysts at the base of the lung. We consider, however, that, if for reasons of local or general order, the application of a more radical method is counterindicated, this simple intervention might, in such a case, give a favorable result like the one that we have just mentioned.

The period after the operation was relatively simple in most of our cases. Some incidents, such as a slight shock, a pulmonary reaction, especially pleural, were not lacking. Only in three cases have we had to treat complications of a purulent pleurisy, which were rapidly cured by appropriate treatment. We have never observed any permanent fistulæ after the operation; as to the bronchic fistulæ which are of a relative frequency, they have always been closed by the progress of the granulation.

Our observations are the following:

CASE I.—C. N., male, aged twenty-six. Since January, 1926, had a cough, a slight expectoration, blood spitting, loss of weight, curvature at the right hypochondrium. In April, 1926, he was operated upon by a surgeon for a hydatid cyst of the liver, without relief. A radiographical examination showed a hydatid cyst of the superior right lobe. He has never had fever nor signs of bronchic rupture.

June 3, 1926, operation: first step. Resection of a part of the fourth rib. Absence of adhesions. Fixation of the lung. Tamponing.

June 16, 1926, second step. Adhesions formed. Puncture and evacuation of pure watery liquid. Incision of the lung. Ablation of the mother membrane and of its contents. Drainage. Normal progress after the operation.

In January, 1930, he was again operated upon for a very big hydatid cyst of the liver. Cure.

CASE II.—T. A., boy, thirteen years old. Since 1923 has complained of a pressure and pain of the left hemothorax and hypochondrium, cough, an inspiratory dyspnoea, repeated blood spittings followed by shiverings, perspirations, fever. He had attacks of vomiting (liquid sanguinopurulent, putrid, with numerous membranes). His abdomen presented a tumefaction having to the touch the characteristics of a hydatid cyst of the lung. At the left basis of the thorax diminution of the respiratory movements, dullness, respiratory silence, and some clamorous râles. Radioscopy gave a circular shadow with two zones, one clear, the other obscure (surface watery). Blood: white cells, 16,100; eosinophiles, 7 per cent.

December 4, 1926, operation: first step. Resection of a part of the sixth rib. Absence of adhesions. Fixation of the lung. Incision of the pleura. Tamponing.

December 18, 1926, operation: second step. Exploratory puncture. Incision of the lung, and evacuation of dirty pus and of daughter vesiculæ. Tamponing. Progress after the operation, normal.

January 18, 1927, the patient was re-operated upon for a non-suppurating hydatid cyst of the left lobe of the liver. Cure.

CASE III.—P. E., woman, forty years old. Since 1910 she had repeated pain in the right hypochondrium radiating over the shoulder, with a fébrile movement. In 1911, vomit (sanguinary membranes, and small cysts of the thickness of a small peanut). In November, 1927, more intense crisis, with fever and shivers. Liver enlarged, muscular resistance, and pains at the level. At the right base of the thorax, subdulness and respiratory murmur abolished. Blood: white cells, 9,300; eosinophiles, 1 per cent.

GEORGE CARAYANNOPOULOS

December 23, 1926, operation for a suppurating hydatid cyst of the right lobe of the liver. Progress after the operation, normal at first, but, a month later, developed fever with dullness of the right base. Exploratory puncture gave pus with streptococci.

February 10, 1927, operation, resection of a part of the tenth right rib. Pleural adhesions. Exploratory puncture, incision of the lung, and evacuation of a purulent liquid with fragments of hydatid membranes. Tamponing, drainage. Progress after the operation, normal. Cure.

CASE IV.—V. I., male, twenty-seven years old. Since February, 1926, has had thoracic pains at the right. In the right axillary region of the thorax there is subdulness with diminution of the vibrations and of the respiratory murmur. Blood: eosinophiles, 4 per cent. Weinberg's reaction, negative. Radiography, circular shadow of the medium part of the right hemothorax.

March 29, 1927, operation, resection of a part of the fourth rib. Presence of adhesions. Incision of the lung and evacuation of a cyst of the diameter the size of an orange, of clear contents. Ablation of the mother membrane. Small drainage following Professor Geroulanos' method. Suture. Progress after operation, normal. Cure.

CASE V.—S. M., man, nineteen years old. Since January, 1925, had pains in the right hypochondrium radiating to the scapula, more intense pains at deep inspirations, then blood spittings with a light fébrile movement, cough and notable expectoration. The thorax at the back, at the right, median part, dull and resistant to the finger, framed by a zone of subdulness; at the same level; respiration diminished, subclamorous râles, light souffle. Radiography, circular shadow.

October 20, 1927, operation, resection of a part of the seventh right rib. Incision of the pleura. Absence of the adhesions at that level; on the contrary they are to be found slightly higher. Suture of the open pleura. Resection of a part of the sixth rib. Firm adhesions. Exploratory puncture. Incision of the lung and evacuation of a cyst of the dimensions of an orange, containing dirty pus and daughter vesiculæ. Tamponing. Progress after operation, normal. Cure.

CASE VI.—C. H., girl, sixteen years old. Since October, 1927, she had twice a pain at the left thoracic base with fever, cough, anorexy, and blood spitting. At the back of the thorax at the left base, dullness, diminution of the respiratory murmur, hissings and râles. Blood, eosinophiles, 1 per cent.

January 17, 1928, operation, resection of portion of the left seventh rib. Presence of adhesions. Incision of the lung. Evacuation of a big cyst of clear contents. Ablation of the mother membrane, small drainage after the method of Geroulanos. Suture. Progress after the operation, normal. Cure.

CASE VII.—V. N., man, twenty-four years old. Since April, 1928, had a pain at the base of the left hemothorax, soon followed by vomiting (clear liquid). Later, fever, with a daily abundant expectoration, purulent and dirty. In addition, general weakness, paleness, loss of weight. The thorax at the left presented a light curvation, absolute subdulness and dullness; diminished vibrations; respiratory murmur diminished and abolished. Blood: white globules, 11,800; eosinophiles, 4 per cent. Weinberg's reaction, positive (+ + + +).

October 13, 1928, operation, resection of a part of the left eighth rib. Presence of adhesions. Incision of the lung. Evacuation of pus and numerous daughter vesiculæ. Drainage. Tamponing. Progress after operation, normal. Cure.

CASE VIII.—N. T., man, forty years old. Since 1924 had, as a result of an irritative cough, a notable blood spitting which was repeated. Later he had dyspnoea, very frequent expectorations, often sanguinary and containing, sometimes, daughter vesiculæ, of the dimensions of a peanut; in addition he had fever and an urticarial eruption. The thorax at the level of the left armpit diminished, respiratory murmur and vocal vibrations. Blood, eosinophiles, 1 per cent. Weinberg's reaction, doubtful ( $\pm$ ). Radiography, net circular shadow at the medium part of the left hemothorax.

November 24, 1928, operation, resection of a part of the seventh rib. Presence of

## HYDATID CYSTS OF THE LUNG

adhesions. Exploratory puncture. Incision of the lung, and evacuation of abundant pus. Ablation of the mother membrane. Drainage. Tamponing. Progress after operation, normal. Cure.

CASE IX.—S. P., girl, seventeen years old. Since 1927 has felt in the right hemithorax at three different times a pain which lasted only one day with a slight fébrile movement; in addition a slight dry cough. Examination revealed at the back of the thorax at the right at the median part, subdulness, some fine subclamorous râles, musical noises; in front, at the corresponding region, subdulness, diminution of the respiratory murmur, some small friction noises. Blood: anæmia white globules, 7,500; eosinophiles, 2 per cent. Weinberg's reaction, negative.

May 5, 1929, operation, resection of the antero-external part of the fourth right rib. Presence of loose and limited adhesions. Exploratory puncture. Incision of the lung. Evacuation of the cyst (liquid of doubtful nature). Ablation of the mother membrane. At one point, owing to the lack of adhesions, the pulmonary incision communicated freely with the pleural cavity. Drainage according to the Geroulanos method. Suture.

After the operation, the patient had fever, which was not controlled by the evacuation of serosanguinary liquid by the drain. The wound was then opened throughout and tamponed; the fever persisted; finally there appeared unmistakable signs of pleural infection of the right base; exploratory puncture gave streptococcic liquid. June 8, 1929, a typical operation for purulent pleurisy was done. The progress after this operation was normal and cure followed.

CASE X.—P. I., boy, fifteen years old. Since 1926 had an irritative cough, and expectoration of foamy blood, with fragments of membrane. The thorax, in front, to the left at the upper part gave subdulness, vibrations and greatly diminished respiratory murmur. Blood, eosinophiles, 1.50 per cent. Weinberg's reaction, negative.

June 22, 1929, operation: first step. Resection of a part of the fourth left rib. No adhesions. Resection of a part of the third rib. No adhesions. Fixation of the lung. Incision of the pleura. Tamponing.

July 7, operation: second step. Adhesions developed except down at the left where the pleural cavity was protected by a provisional tampon. Evacuation puncture gave clear liquid. Incision of the lung. Ablation of the mother membrane. Drainage. Tamponing. After operation the cystic cavity was not purulent but there was yellow liquid in a space limited by adhesions and communicating with the wound caused by the operation. Dressing twice daily. Also, at the left base slight and passing signs of pleural effusion. These incidents lasted but ten days only. Cure.

CASE XI.—P. Th., man, twenty-five years of age. Since April, 1929, had pain in the right hypochondrium radiating to the shoulder, dry cough, some chills. He has been punctured for pleurisy. Evacuated 400 grams of yellow liquid. In addition there were bloody expectorations. The thorax gave subdulness at the upper right part, absolute dulness at the base; diminished vibrations at the upper part, abolished at the base; respiratory murmur diminished at the upper part, abolished at the base; subclamorous râles at the medium part. Radioscopy: shadow spreading over almost the whole right lung. Blood anæmia, eosinophiles, 1 per cent. Weinberg's reaction, positive.

September 24, 1929, operation, resection of a part of the eighth right rib. Presence of adhesions. Puncture, evacuated seropurulent liquid; incision of the lung, ablation of the mother membrane, drainage. Progress after operation, normal. Cure.

CASE XII.—C. Z., woman, forty years of age. In November, 1928, developed pain in the right hemithorax hindering deep inspiration as well as the station in the right lateral decubitus. This pain was replaced later by a periodic feeling of uneasiness. In the thorax behind, at the right base, the inspiratory amplexness was diminished. In the abdomen the liver slightly projected below the costal margin. Casoni's cuti-reaction, positive. Radioscopy: circular shadow of the base of the right hemithorax, the limits of which are confounded with the hepatic dome.

GEORGE CARAYANNOPOULOS

November 12, 1929, operation, resection of the posterolateral part of the tenth and eleventh right ribs. Ablation of the intercostal muscles. Absence of adhesions. Wide opening of the pleura and production of a complete progressive artificial pneumothorax. The inferior lobe of the lung was occupied by a cyst of the size of an orange. Tamponing and drainage of the pleural cavity. Evacuative puncture of clear liquid. Movement of the cyst towards the exterior. Opening of the cyst and ablation of the mother membrane. Small drainage according to the Geroulanos method. Suture and fixation of the cyst to the side. Progress after operation, normal. Cure.

CASE XIII.—S. P., man, twenty-five years old. Entered Evangelismos Hospital, December 7, 1930. Thirteen days prior to his entrance to the hospital he had been suddenly seized by an irritative cough accompanied with vomits. This cough persisted until he entered the hospital, accompanied with abundant mucopurulent expectoration.

A few days after the beginning of his illness, his temperature reached  $38^{\circ}$  and continued up to the day he entered the hospital. In the thorax, behind and at the right base, the inspiratory amplexity was diminished. At this level there was complete dullness, and important diminution of the vesicular murmur. Nothing particular at the level of the right superior lobe. Also, nothing important at the level of the left hemithorax. In the abdomen the liver projected below the false ribs to the width of two fingers. The microscopical examination of the expectoration revealed the existence of staphylococci; no tania hooklets; Koch, negative. At the radiographical examination we found a circular shadow at the base of the right hemithorax of the size of a foetal head, the superior part of which was full of gas, and the inferior contained liquid, the rectilinear level of which changed position in the radiograph when the patient was moved. Casoni, negative. Urine, normal. *Diagnosis*.—Broken, suppurating hydatid cyst, at the level of the inferior lobe of the right lung.

After having well localized the position of the cyst by means of the radioscopical examination, operation was done December 18, 1930. Incision approximately ten centimetres at the level of the ninth rib at the posterior face of the thorax. Resection of about ten centimetres of this rib. The pleura was adherent to the lung, and consequently the incision could be made directly into the cyst which was lying at the depth of about two centimetres. A great quantity of dirty pus was evacuated, and the mother vesicula was ablated. No daughter vesiculæ. Drainage. Immediately after the operation the temperature became normal. The patient got up on the tenth day and left the hospital one month after the operation to return for dressings. Two and a half months after the operation he was cured.

CASE XIV.—M. C., man twenty-nine years old. Entered Evangelismos Hospital, November 10, 1930. For one year he had been feeling tired and his temperature went up to  $37.5^{\circ}$  without any other symptom. As time passed his temperature was increasing and reached  $40^{\circ}$  (at night). He was not complaining of any pain, neither of blood spitting nor of any other symptom. No cough nor expectoration. On the day of his entrance, subdulness at the height of the scapula, with a sensible diminution of the vesicular murmur. In front, subdulness at the level of the fifth rib with a marked diminution of the vesicular murmur. No noise of friction nor râles. A radiography gave a shadow of an oval shape with well-limited borders, of the size of an orange, situated at the median third of the left lung. The rest of the left lung as well as the right lung was of normal appearance. Nothing towards the side of the abdomen. Casoni, positive. Eosinophiles, 3 per cent. *Diagnosis*.—Suppurating hydatid cyst of the left lung.

First operation, November 15, 1930. Under general anæsthesia, a part of the front rib was resected. After the resection of the rib, the underlying lung appeared to be free of adhesions. A part of the fourth rib was then resected, but there also, through the pleura, it was seen that there were no adhesions. Then the lung was fixed to the parietal pleura, circularly, by catgut, and in separated points. At one point, the parietal

## HYDATID CYSTS OF THE LUNG

pleura was torn by the threads and there a small compress was introduced. Tamponing of the wound. Partial suture of the skin.

The second step was taken December 2, 1930. At the level of the old incision the soft parts were detached, the pleura was exposed. The small compress which was put in at the first operation was removed. It was evident that adhesions had been formed between the lung and the pleura. Then the pulmonary parenchyma was incised. The cyst was found situated at the depth of three centimetres. Incision of the cyst and ablation of the mother vesicula, which contained a liquid slightly turbid. The lung was sutured, and a small fine drain was introduced into the interior of the cavity, the exterior end of which was tied by a silk thread. After this second operation, the temperature of the patient became normal. The drain was removed on the eighth day, but there occurred a suppuration of the parietal wound. The patient left the hospital completely cured February 7, 1931.

CASE XV.—D. S., forty-two years old, entered the hospital December 1, 1930. For two years he had complained of pains at the level of the posterior face of the right hemithorax, accompanied by abundant and filthy expectorations, and continued fever which reached  $38^{\circ}$ – $39^{\circ}$ . When he entered Evangelismos, his temperature at night was  $38.2^{\circ}$ . The thorax gave subdulness at the base of the right lung with noise of friction, and deep subclamorous râles. Left lung was in normal condition. Urine, normal. Casoni, negative. The radiograph showed a circular shadow of the volume of an orange at the level of the inferior lobe of the right lung. The superior part of the shadow contained gas, and the inferior part contained a liquid the level of which changed position when the patient was moved. The sputum did not contain Koch's bacillus, nor hooklets. The patient remembered having expectorated fragments of vesicula.

Operation, December 9, 1930. Local anæsthesia. Incision ten centimetres long on the posterior face of the right hemithorax at the height of the eighth rib, part of which was resected. Adhesions between the pleura and the lung. The pleura and the pulmonary parenchyma, which was about two centimetres thick, were incised, opening a cavity full of filthy pus, and fragments of mother vesiculæ. The cavity was well dried, drainage. Partial suture of the wound. The patient left the hospital on April 3, 1931, completely cured.

CASE XVI.—V. S., girl, eight years old, entered the hospital September 22, 1930. A year before she had fever fluctuating between  $37.2^{\circ}$ – $38^{\circ}$ . No other symptom at the beginning. Some days later, she had an abundant expectoration of a clear liquid, and only once she had sanguinary sputum. One month later, she entered the hospital at Janina (Epire) where the diagnosis was a hydatid cyst of the lung and she was immediately operated upon.

After staying fifty days at the hospital, the wound was completely cicatrized, and she left, apparently cured. One month later, she started again having a temperature up to  $37.5^{\circ}$ , with no other symptoms. When she entered the hospital, her temperature was normal. Cicatrix at the level of the sixth rib of the posterior face of the left hemithorax. At the level of the seventh rib, behind, and between the two axillary lines, there were dulness and a diminution of the vesicular murmur. No expectoration. Right hemithorax, normal. Abdomen, normal. Urine, normal. Casoni, positive. Weinberg, positive. Eosinophiles, 2 per cent. The radiograph gave an oval shadow with clear limits, situated at the left hemithorax between the fourth and the tenth rib.

Operation under local anæsthesia on September 27, 1930. Incision parallel to the ninth rib between the two axillary lines, anterior and posterior. After the resection of a part of this rib, it was evident that the underlying lung was adherent to the pleura. The pleura and the lung were then incised, and at a depth of 1.5 centimetres the cyst was opened. Ablation of the mother vesicula which did not contain daughter vesiculæ, and the liquid was clear as rock water. Partial suture of the lung. Drainage of the



cavity by means of a very fine tube. Suture of the side. After the operation, the temperature became normal again. The drain was removed on the eighth day. The patient left the hospital on October 23, 1930, completely cured.

CASE XVII.—H. P., woman, fifty-eight years old, entered the hospital July 2, 1930. Temperature,  $39^{\circ}$ . For five months, the patient had felt tired and had a temperature which went up to  $38.5^{\circ}$  at night. She also complained of an irritative cough with mucopurulent expectoration and twice bloody. For one month she had complained of a pain at the base of the right hemithorax, which was accentuated at the moment of inspiration. At the level of the base of the right hemithorax there was a subdulness which extended up to the middle of the scapula. The same subdulness was found also between the two axillary borders. At the level of this subdulness, noises of friction could be heard with sensible diminution of this vesicular murmur. Round this subdulness some unstable râles could be heard. The rest of the lung normal. Left lung, normal. Nothing at the side of the abdomen. The radiograph gave a shadow of the shape of a foetal head localized at the level of the inferior lobe of the right lung, the limits of which were very clear. Urine, normal. Eosinophiles, 2 per cent. Weinberg, slightly positive.

Operation under local anæsthesia July 8, 1930. Incision between the two axillary borders at the right, and at the height of the fourth intercostal space. Resection of a part of the fifth rib. No adhesions between the pleura and the lung. The pleura was slightly opened and its cavity was isolated by means of compresses. The lung was caught with heart forceps and the parenchyma was incised. The cyst was found at the depth of about 1.5 centimetres. The contents were clear. Ablation of the mother vesicula. No daughter vesiculæ. Drying of the cavity. Suture of the lung. Fixation of the lung to the pleura and the intercostal muscles. Introduction of a small drain into the cavity, the exterior end of which was tied by a silk thread. After the operation, the temperature remained round  $37.5^{\circ}$ , to go up, at the end of the third day to about  $38.5^{\circ}$ . At the end of the sixth day, the drain was changed, and through the drainage hole flowed abundant pus. New drainage by a bigger tube. From that moment the general condition ameliorated and the temperature had a tendency to fall. On the twenty-seventh day after the operation, the formation of liquid in the right pleural cavity was perceived. Puncture with evacuation of pus containing pneumococci, and some goldish staphylococci.

Resection of the eleventh rib at the level of the costal angle on August 5, 1930.

Opening of the pleura and evacuation of a considerable quantity of pus. Hermetic drainage following Delbet's procedure. From that moment, the patient's condition was progressively and rapidly ameliorated. She left the hospital September 17, 1930, cured.

CASE XVIII.—E. A., man, thirty-five years old, entered the hospital September 9, 1930. For a month he had complained of dyspnœa with a feeling of pressure at the level of the sternal region, especially after being tired. No cough nor expectoration. Normal temperature,  $36.8^{\circ}$ . At the base of the right hemithorax, subdulness and diminution of the vesicular murmur, especially at the back. Left lung, normal. A radiograph showed a shadow, clearly limited, of the size of an orange, situated at the base of the right lung. Nothing towards the side of the abdomen. Casoni, negative. Weinberg, negative.

Operation September 16, 1930. Local anæsthesia. A part of the seventh rib was resected at the posterior face of the thorax. No adhesions between the pleura and the lung. The pleura was incised and the lung was caught with heart forceps. A catgut thread was passed on the surface of the lung immediately over an induration which could be felt by palpation in the interior of its parenchyma. The pleural cavity was protected by compresses and the lung was incised at the level of the above-mentioned induration. The cyst was found at a depth of about one centimetre. Its side was incised, and the mother vesicula was taken off. The liquid contained therein was clear. No daughter vesiculæ. Suture of the pulmonary incision and fixation of the lung on the parietal pleura by some points of catgut. Drainage by a small fine drain, the exterior

## HYDATID CYSTS OF THE LUNG

end of which was tied by a silk thread. After the operation the temperature reached  $38^{\circ}$ . On the fourth day some pus escaped from the tube, which increased in amount the following days. Thirteen days after the operation, the patient presented symptoms of a pleural effusion. Puncture of the pleura gave pus containing staphylococci.

October 2, 1930, under local anæsthesia, resection of the ninth rib and drainage of the pleural cavity which contained a considerable quantity of pus. After this second operation, the temperature continued around  $38^{\circ}$ – $39^{\circ}$ . To control this injections every two days of three centimetres of propidon were instituted. Six days after the third injection, the temperature became normal again. The patient left the hospital December 1, cured.

CASE XIX.—A. D., woman, forty years old, entered the hospital February 8, 1931. For ten years she has suffered intermittent pains at the level of the thorax, without precise localization. Two years before she had had blood spitting up to about 100 grams of blood. This blood spitting was repeated five months ago, accompanied with an irritative cough. For two months, a pain was localized at the level of the right hemithorax, especially at the scapular region, and at the same time, in the sputum were seen fragments of vesiculæ mixed with pus. No fever. Temperature,  $36.5^{\circ}$ . Dulness at the level of the left hemithorax, from the middle of the scapular region up to the tenth rib. At this level, the vesicular murmur was considerably diminished. No friction noise. Through the rest of the lung nothing particular. Right lung, normal. Abdomen: The liver projects below the false ribs by four fingers. It is a little hard and aches when pressed. A radiograph gave a shadow of the size of a big orange, situated at the middle of the left lung. This circular shadow had clear limits and covered half the shadow of the heart. Eosinophiles, 1 per cent. Casoni, positive. Urine, normal.

Operation March 17, 1931. Under local anæsthesia an incision of eight centimetres was made, at the height of the ninth rib behind the thorax, and about three centimetres from the spinal cord. Resection of about six centimetres of the ninth rib. No pleuropulmonary adhesions. Incision of the pleura and drain of the cavity by gauze. The lung was caught by heart forceps, and was incised to a depth of 1.5 centimetres where the cyst was found. Ablation of the mother vesicula. No daughter vesiculæ. The liquid was slightly turbid. Partial suture. Drainage. The next day after the operation, temperature  $39^{\circ}$ , and abundant blood expectoration. On the third day the temperature became normal. The drain was removed on the thirteenth day, and on April 20 she left the hospital, still having a small wound. When she came for the dressing, twenty-five days later, she was cured.

CASE XX.—K. B., man, thirty-five years old, entered the hospital March 19, 1931. In 1927 he vomited pus mixed with fragments of mother vesicula. Immediately after, he spat about sixty grams of blood. Since then, from time to time, he noticed blood filaments in his sputum. During an attack of dengue fever in 1928 his pulmonary condition was aggravated, and he again vomited pus and blood. Since then his condition alternately had been ameliorated and aggravated. Six months ago he was spitting blood almost every day. Temperature  $36.7^{\circ}$ . Subdulness at the level of the base of the right hemithorax, soft souffle and notable diminution of the vesicular murmur. Nothing abnormal at the side of the left lung. Abdomen, nothing abnormal. He was abundantly spitting blood. Urine, normal. Casoni, positive. A radiograph gave an elliptic shadow of the size of a hen's egg at the base of the inferior lobe of the right lung.

Under local anæsthesia April 1, 1931, an incision about twelve centimetres was made at the height of the ninth rib, at the posterior and lateral face of the right hemithorax. Resection of about ten centimetres of that rib as well as of the eighth. Ablation of the intercostal muscles. Pleuropulmonary adhesions existed. Puncture gave pus at depth of about three centimetres. The pleura and the lung were incised as well as the cyst containing pus. Ablation of fragments of the mother vesicula. No daughter vesiculæ.

GEORGE CARAYANNOPOULOS

The volume of the cyst is of a big orange. Marsupialization and drainage of the cavity. Partial suture of the soft parts. The next day after the operation, temperature  $38.5^{\circ}$ , which continued up to the eleventh day after the operation, when temperature became normal again. On the thirteenth day the drain was removed. The cavity progressively contracted and the patient left the hospital April 28, 1931, still having a slight wound. A month later he was completely cured.

CASE XXI.—A. C., boy, seventeen years old, entered the hospital February 23, 1932, suffering from an osteomyelitis of the right tibia with abscess. At the same time he had dulness at the level of the left hemithorax, with total suppression of the vesicular murmur and absolute lack of vibrations from the scapular region up to the base. Temperature,  $38.5^{\circ}$ . Casoni, negative. White blood cells, 10,050. Urine, normal. A radiograph showed the left hemithorax almost completely covered by a shadow which covered the shadow of the heart, spreading from the region under the apex to the base. At the level of the apex there was another circular shadow, the size of a small orange, containing gas. In the abdomen, the liver and the spleen slightly projected beyond the false ribs. *Diagnosis*.—Abscess of the left lung and purulent pleurisy as a sequence of a septicemic condition with osteomyelitic origin.

On February 29, 1932, under local anaesthesia, an incision was made at the height of the tenth rib at the back, and on the sides of the left hemithorax. Resection of a part of that rib. Incision of the pleura and evacuation of a great quantity of pus containing daughter vesiculæ which were free in the pleural cavity. The lung was contracted round the spinal column. The lips of the incision were well retracted by the opening of the over and underlying ribs, and an orifice was distinguished on the inferior border of the superior lobe, and through this orifice, of the size of a shilling, pus was flowing. This orifice was enlarged, opening into a cavity containing fragments of mother vesicula, and some daughter vesiculæ. Drainage of the general pleural cavity. After the operation, the temperature progressively fell until it became normal, to go up again around  $38^{\circ}$ .

March 15 he was operated upon for the osteomyelitis by trepanation and cleaning of the tibia. The patient left the hospital July 9, 1932. The left lung was almost completely cured. No shadow was any more seen, except for a certain opacity at the level of the left hemithorax. The left lung was breathing well; no expectoration. The wound of the tibial trepanation was not completely cicatrized when he left, but it was on a good path of cicatrization.

CASE XXII.—M. G., man, twenty years old, entered the hospital December 1, 1930. For six weeks he had complained of attacks of a sharp pain of short duration at the level of the right hypochondrium. For some days he had felt a friction when breathing at the posterior face of the base of the right hemithorax. No other symptoms. No cough. No expectoration, no fever. Temperature,  $36.8^{\circ}$ . Subdulness behind at the level of the base of the right hemithorax, and diminution of the vesicular murmur at that level, and between the two axillary borders; the rest of the lung as well as the right lung in normal condition. A radiograph gave a circular shadow of very clear limits at the level of the base of the right lung. This shadow was confounded with the shadow of the diaphragm. Casoni, positive. Urine, normal. Nothing towards the side of the abdomen.

Operation, December 9, 1932, under local anaesthesia. Incision along the ninth rib between the two axillary borders; resection of a part of that rib. No pleuropulmonary adhesions. To obtain adhesions iodoform gauze was placed on the pleura, and the soft parts were partially sutured. Second operation, December 28, 1932. During this lapse of time the patient had no fever. The iodoform gauze was removed and the pleura was found to have thickened. The incision demonstrated that there were no adhesions between the lung and the pleura. Immediately a pneumothorax was made which pushed the lung upwards and towards the spine, which obliged us to resect another portion of the eighth rib. Then the lung was caught by heart forceps, and was drawn

## HYDATID CYSTS OF THE LUNG

to the level of the incision. A prominence of spheric shape was seen at the level of the base of the inferior lobe of the lung. After having cleaned the cavity with compresses, the pulmonary parenchyma was incised, opening into the cavity of a cyst containing clear liquid. Ablation of the mother vesicula. No daughter vesiculæ. Drying of the cavity, partial suture, drainage. Progress after the operation normal. The patient left the hospital, cured, on January 25, 1933.

CASE XXIII.—A. S., woman, twenty-five years old, entered the hospital June 21, 1932. For three months before her entrance she had complained of pains at the level of the left hemithorax. These pains became stronger at the moment of inspiration. From time to time she had also suffered from crises of a dry cough. Ten days prior to her entrance she had a light blood spitting. Temperature,  $36.8^{\circ}$ . Casoni, slightly positive. Eosinophiles, 3 per cent. The examination of rare sputum did not reveal the existence of hooklets. Urine, normal. A radiograph gave a shadow of the size of an egg at the level of the left lung which was a continuation of the shadow of the heart.

Operation, June 24, 1932, under local anaesthesia a part of the seventh rib was resected at the posterior end. No pleuropulmonary adhesions. The pleura was incised, and the underlying lung was caught by two heart forceps. By palpation, no characteristic induration was felt, which might indicate the existence of a tumor. By puncture at a depth of approximately six centimetres the cyst was found and a clear liquid was taken therefrom. Hardly two cubic centimetres of liquid were drawn when the patient was caught by an intense dyspnoea with cyanosis. The needle was immediately withdrawn and the pulmonary parenchyma was incised with the bistouri. Before the cyst could be exposed the patient was already dead. All efforts to bring her back to life were in vain.

CASE XXIV.—P. M., boy, eight years old, entered the hospital April 22, 1933. A year before the patient was treated for two months for a pleurisy; a year later, after a measles which had lasted for eight days, he developed fever which reached  $40^{\circ}$ , accompanied with chills and a pain localized at the level of the right hemithorax. When he entered the hospital his temperature was  $39.5^{\circ}$ , general condition rather bad. On examining the thorax, a dullness was found at the level of the superior third of the right hemithorax, behind and in front, with diminution of the vesicular murmur and suppression of the vibrations. Same symptoms in the axillary region. The rest of the lung as well as the left lung in normal condition. White cells, 12,500. No eosinophiles. Casoni, slightly positive. Urine, normal. A radiograph gave a shadow of the size of a big orange with clear limits at the level of the right lung. This shadow extended from the top up to the middle of the lung; its superior part less opaque indicating the existence of gas.

Operation, April 26, 1933, under local anaesthesia. An incision of about eight centimetres was made at the height of the fourth rib on the anterior face of the thorax, a part of this rib was resected; existence of pleuropulmonary adhesions. The pleura and the lung were incised and at a depth of one centimetre the cyst was found containing purulent and dirty liquid. Ablation of the mother vesicula. No daughter vesiculæ. Drainage by means of a rubber tube and some compresses. Partial suture of the wound. The next day, after the operation the temperature became normal, maintained at this level, up to May 25, 1933, on which day the boy left the hospital with only a superficial wound. He returned for dressings and one month later his wound had cicatrized.

CASE XXV.—P. D., man, thirty years old, entered the hospital April 26, 1933. For two months he had felt tired, and from time to time had spat a little blood with a fugitive pain at the level of the right hemithorax. For thirteen days this pain had become very strong and was accompanied with small blood expectoration. Temperature,  $37.2^{\circ}$ . General condition, satisfactory. White cells, 7,500. Eosinophiles, 2 per cent. Weinberg, negative. Casoni, strongly positive. Subdulness at the level of the right

GEORGE CARAYANNOPOULOS

hemithorax behind and on the sides from the inferior angle of the scapula up to the base. At that level diminution of the vesicular murmur. No râles. Some friction noises. The rest of the lung and the left lung in normal condition.

First operative step: May 10, 1933, under local anaesthesia an incision of ten centimetres was made at the height of the ninth rib behind on the posterior face of the thorax. Six centimetres of that rib as well as of the eighth were resected. Adhesions were found at the level of the superior limit of the wound. On the rest of the pleuropulmonary region no adhesions. By palpation of the lung through the nonincised pleura no hardness indicating the existence of a cyst could be felt. Tamponing with iodoform gauze was made, and the wound was partially sutured. After a new radioscopical localization the cyst was found a bit higher.

Second operation, May 19, 1933, local anaesthesia, part of the seventh rib resected, pleuropulmonary adhesions found, the pleura was very thick at the level. It was incised

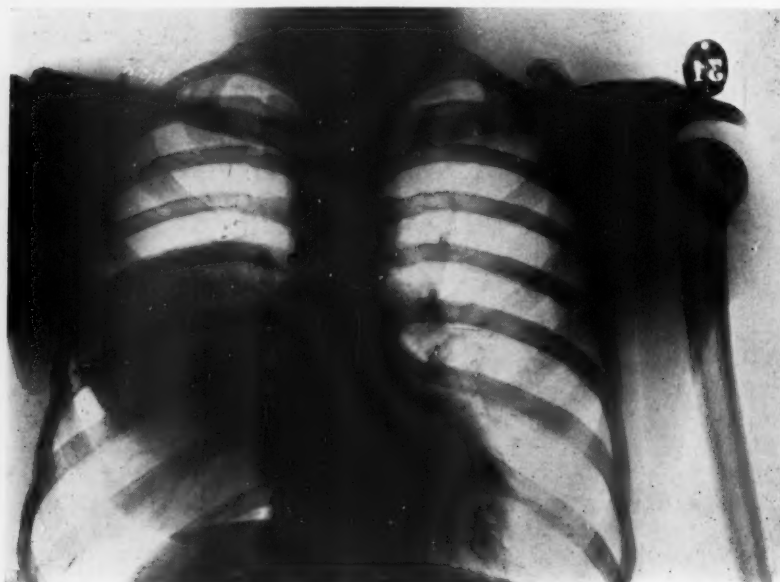


FIG 3.—(Case XXVI.) Radiographical image indicating two superposed cysts of the right lung.

and right underneath the cyst was found, sticking to one which contained clear liquid (rock water). Ablation of the mother vesicula. No daughter vesiculæ. After this ablation, a bleeding, not very abundant, which filled the cavity of the cyst, obliged us to tampon with two compresses, and partially suture the wound of the lung. The progress after the operation was normal and the patient left the hospital June 8, 1933, still having a small wound about four centimetres deep. After three weeks the wound had completely cicatrized.

CASE XXVI.—J. C., man, twenty-five years old, entered the hospital May 8, 1933. Eight months previously he had a pulmonary infection which lasted, he said, about one month. Twenty days ago he felt tired and his temperature went up to  $37.5^{\circ}$ – $38^{\circ}$ . Some days later he spat blood, and his temperature continued round  $38^{\circ}$ . From time to time he was feeling a slight pain at the level of the right hypochondrium. When he entered his temperature was  $37.2^{\circ}$ . White cells, 9000. Eosinophiles, 2 per cent. Weinberg, negative. Casoni, negative. The right hemithorax a little more prominent than the left one. Subdulness at the right and behind from the scapula up to the base. Same



## HYDATID CYSTS OF THE LUNG

symptoms between the two axillary borders. In addition, certain noises of friction. In front, nothing abnormal. Left lung in normal condition. Nothing towards the side of the abdomen. A radiograph (Fig. 3) showed two shadows at the level of the mean inferior lobe of the right lung. These shadows were very distinct, and were superposed up to their middle, the superior shadow rather elliptic and parallel to the ribs. A small space could be seen, very fine, of pulmonary tissue separating the two cysts. The inferior cyst was attacked first.

May 25, 1933, under local anaesthesia, an incision was made at the posterolateral face of the right hemithorax, at the height of the eighth rib; eight centimetres of that rib were resected. No pleuropulmonary adhesions. The pleura was incised and the lung was caught with forceps, and with a circular catgut suture it was attached to the side. By palpation the cyst could be felt underneath. The lung was incised and at a depth of a few centimetres the side of the cyst was opened. It contained a clear liquid. Ablation of the mother vesicula. No daughter vesiculæ. Drying of the cavity by com-

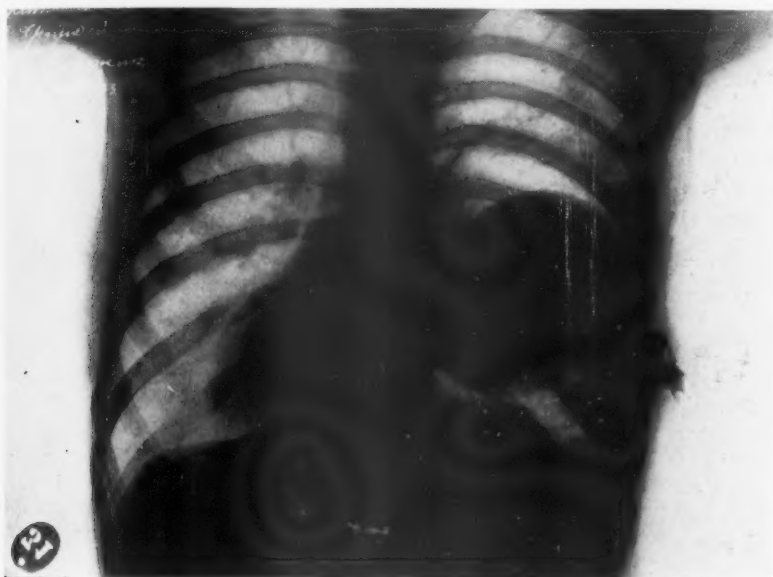


FIG. 4.—(Case XXVI.) Radiography after one of the two cysts had been operated upon.

presses. Since a finger introduced into the cavity could not feel another cyst it was decided to postpone for a few days the evacuation of the second cyst. The lung was partially sutured. Drainage. A second radiograph (Fig. 4) made a few days after this operation showed that over the cavity indicated by a tube there existed another cyst of the size of an orange. In the morning of June 9, 1933, while the dressing was being made this second cyst suddenly broke into the cavity of the first. Through the orifice which was created they were able to remove the mother vesicula which contained a purulent liquid. From that moment the temperature became normal. The patient left the hospital June 23, 1933, still having a small wound four centimetres deep which obliged him to come to the hospital for the dressing. By July 25 the patient was completely cured.

CASE XXVII.—M. L., woman, twenty-five years old, entered the hospital January 15, 1931. Twenty-five days previously while enjoying perfect health, she developed an irritative cough accompanied with expectoration of a clear and odorless liquid. Immediately after her temperature went up to  $39^{\circ}$ , which lasted fourteen days, and then round  $37.9^{\circ}$ . The cough crises continued and obliged her to enter the hospital. Temperature,  $36.8^{\circ}$ . General condition, satisfactory. Subdulness from the angle of the scapula up to

GEORGE CARAYANNOPOULOS

the base. At inspiration diminution of the murmur and certain subclamorous râles. Between the two axillary borders subdulness, and diminution of the vesicular murmur also. Friction noises. Rest of the lung normal. Left lung, normal. Nothing towards the side of the abdomen. Casoni, positive. Weinberg, positive. Eosinophiles, 5 per cent. White cells 4,600. The examination of the sputum did not show any tænia hooklets. A radiograph showed a circular shadow of the size of a small orange with clear limits. The superior part of the shadow was much clearer, indicating the existence of gas, the inferior part opaque, the line of demarcation between the two cysts showing the existence of liquid. Left lung, normal.

January 21, 1931, under local anæsthesia, a posterolateral incision was made at the height of the eighth rib. Resection of a part of that rib. At that level pleuropulmonary adhesions existed. Pus was taken off by puncture. An incision was made to a depth of two centimetres, and a considerable quantity of filthy pus was evacuated, contained in a mother vesicula with no daughter vesiculæ. Ablation of the mother vesicula. Drying of

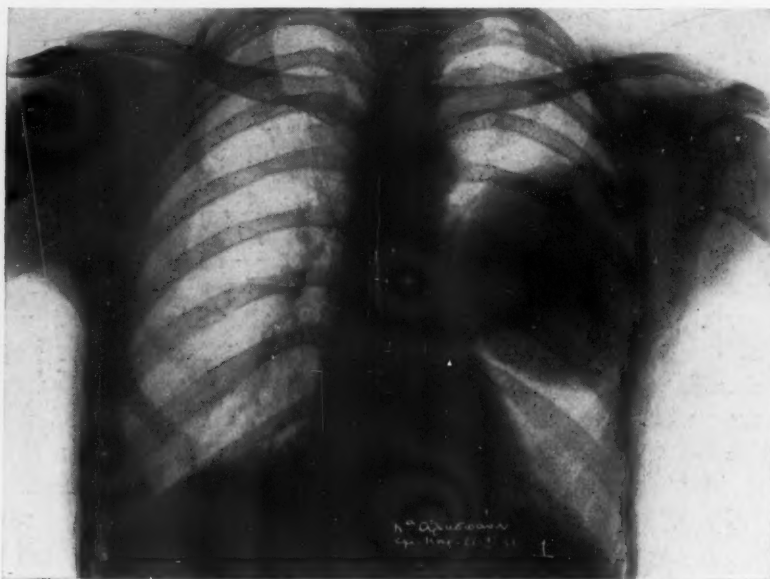


FIG. 5.—(Case XXIX.) Cyst of the left lung before the operation.

the cavity. Drainage. Partial suture of the soft parts. For five days after the operation the patient's temperature fluctuated round 38°. Then it fell to normal level and the patient left the hospital February 23, 1931, having a wound three centimetres deep; she returned for the dressings for twenty days, at the end of which period the wound had completely cicatrized.

CASE XXVIII.—T. S., boy, nine years old, entered the hospital February 7, 1931. For two years and a half he had no appetite and he had lost weight. He was not complaining of any other symptoms. Owing to this loss of weight and the general weakness he was X-rayed in the city; the radiograph showed a shadow of the type of a hydatid cyst at the level of the base of the left lung. Temperature when entering the hospital, 37.2°. Dulness at the level of the base of the left hemithorax behind. At that level, vesicular murmur slightly diminished. The rest of the lung and the right lung in normal condition. White cells, 9,500. Eosinophiles, 5 per cent. Casoni, positive. Urine, normal. The radiograph showed a shadow the size of a hen's egg, rather elliptic, of very clear limits, situated at the base of the left lung, and lying on the left diaphragmatic dome. Weinberg, negative. Nothing towards the side of the abdomen.

February 9, 1931, under ether anæsthesia, a posterolateral incision was made at the height of the eighth left rib. Resection of a part of that rib. Pleuropulmonary adhesions

## HYDATID CYSTS OF THE LUNG

were noticed only on the part of the pleura discovered by the resection. At that level the pleura and the cyst the side of which exceeded the pulmonary surface and adhered to the pleura were incised. Ablation of the mother vesicula containing clear liquid. No daughter vesiculæ. Suture of the lung. Drainage of the cavity by a fine drain. Suture of the wound. Progress after the operation very normal, no fever. The drain was removed on the fifth day. He left, completely cured, at the end of two weeks.

CASE XXIX.—Woman, forty-three years old, entered the hospital August 15, 1933. At the age of fifteen she had a dry left pleurisy which lasted one month. Since that time and especially during the winter she had periodic pains localized over the entire left hemithorax. A month ago she felt also a weight at the level of the left hemithorax. No cough. No spitting. Temperature when she entered the hospital,  $36.8^{\circ}$ . Subdulness at the level of the left hemithorax, from the fourth rib behind up to the eighth. This dulness existed also between the two axillary borders. At that level a soft respiratory souffle could be heard and a diminution of the vesicular murmur. In front, a very slight

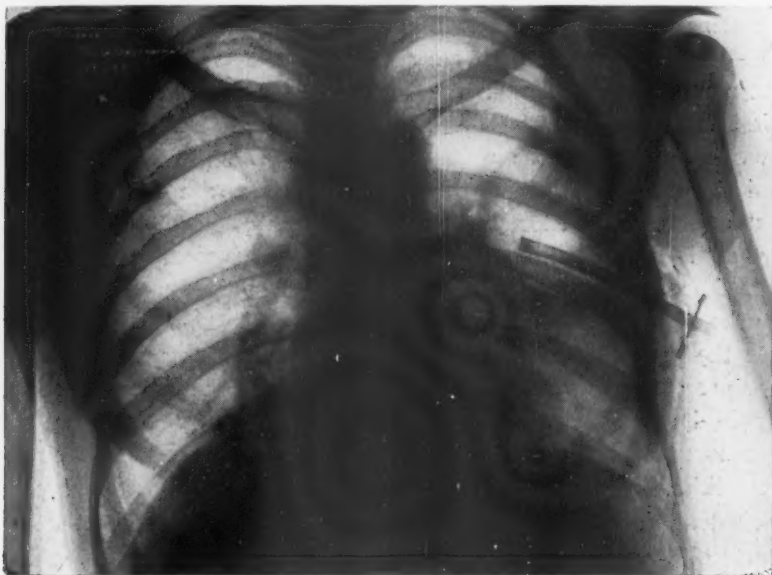


FIG. 6.—(Case XXIX.) Lung radiograph after the operation.

subdulness with a slight diminution of the vesicular murmur from the third rib. Right lung, normal. Nothing towards the side of the abdomen. A radiograph (Fig. 5) showed a circular shadow of the size of a foetal head with very clear limits at the middle of the left hemithorax. Casoni, strongly positive. Weinberg, positive. Eosinophiles, 5 per cent. Urine, normal.

Operation, August 30, 1933. Seven centimetres incision on the posterolateral face of the left hemithorax at the height of the sixth rib. Resection of a part of that rib. Pleuropulmonary adhesions. Incision of the pleura and the parenchyma to a depth of two centimetres, and exactly where the side of the cyst was incised. Ablation of the mother vesicula. No daughter vesiculæ. Clear liquid. Suture of the lung. Drainage with a fine tube. After the operation, and for five days the patient was well, but on the sixth day her temperature went up to  $39^{\circ}$  and the discharge became purulent. Replacing this drain by one of larger calibre caused temperature to fall to normal. The patient left the hospital September 25. She had still a small wound, three centimetres deep, for further dressing. (Fig. 6.)

In 12 cases (41 per cent.), out of the twenty-nine, there have been no pleuropulmonary adhesions, and in seventeen (59 per cent.) there have been adhesions.

## INTESTINAL OBSTRUCTION

ANALYSIS OF 505 CASES FROM THE RECORDS OF  
COOK COUNTY HOSPITAL, CHICAGO, ILLINOIS

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CASES of intestinal obstruction may be classified either from a clinical or a mechanical point of view into (a) acute, (b) chronic, (c) chronic becoming converted into acute, and (d) mechanical. While symptoms will be modified to a lesser or greater degree in different types of obstruction, there are symptoms which are common to all types.

*Pain.*—Onset of sudden, severe pain as a rule is the earliest and most constant symptom, although in the Cook County series of cases (505) in seven it was not present at all and in nine others it was mild. In several cases vomitus preceded the pain. At the beginning the pain is usually localized above and to the left of the umbilicus in case the small bowel is involved, and below and to the left of the umbilicus in cases of large bowel obstruction; later the pain becomes generalized. Occasionally it is present in the right iliac fossa, in the left iliac fossa and in the hypogastrium; occasionally the pain radiates into the back, into the right and left shoulder; in one case the pain radiated into the external genitals; sacral and coccygeal pain was present in one case due to carcinoma of the rectum. The intensity of the pain depends upon the suddenness and on the degree of strangulation, on the amount of bowel involved, and on the character of the bowel; all other conditions being equal, the small bowel being strangulated produces more pain than does the large one. When the pain is intermittent it signifies incomplete obstruction, the shorter the free interval the more acute does the bowel obstruction become, finally constant pain without remission signifies that the obstruction has become complete. The diminution or cessation of pain signifies (a) either spreading intestinal paralysis due to extension of complicating peritonitis, or (b) perforation of the bowel into the free peritoneal cavity, or (c) perforation of some hollow viscus. In cases a and b the general condition of the patient will become worse; in case of c, it will become better.

*Tenderness*, usually absent at the beginning of the obstruction, appears later when peritonitis sets in and thus may be of diagnostic value because peritonitis will set in earlier in closer vicinity at the seat of obstruction than in any other place. Tenderness in our cases was present in 346 cases out of 505 or 68½ per cent.; it ranged from very slight to very severe tenderness. The frequency as far as location was concerned was: (See Table.)

*Rigidity*, rather a late symptom in our series, was present in ninety-seven cases, ranging from very slight to boardlike character. Epigastrium, 18

## INTESTINAL OBSTRUCTION

### LOCATION OF TENDERNESS

	Cases	Per Cent.
Diffuse.....	115	33.2
Lower right quadrant.....	47	13.6
Epigastric.....	42	12.1
Lower left quadrant.....	36	10.4
Hypogastric.....	33	9.5
Umbilical.....	30	8.7
Exact place not specified.....	43	12.5

cases; diffuse, 18 cases; lower right quadrant, 17 cases; hypogastrium, 11 cases; umbilical, 11 cases; lower left quadrant, 3 cases; exact place not specified, 28 cases. It was more frequently present where diffuse tenderness of very marked degree was present. It was usually most marked where severe tenderness was present. There were cases in which no tenderness and still diffuse rigidity was present. Collapse develops early only in super-acute cases of obstruction. It is more marked in strangulation of the small than of the large intestine.

*Vomiting* next to pain is the most common symptom of intestinal obstruction except in intussusception; in our series it appeared in 450 cases, 87.1 per cent. A few cases, however, are reported in which vomitus preceded pain; in our series this occurred in twelve cases. The contents of the vomitus change in the course of the disease. At the beginning it consists of the food taken immediately before the attack occurred; later on bile becomes mixed with the gastric contents. With the progress of the disease the vomitus changes to that of the moderately decomposed contents of the small bowel, later the odor becomes feculent, very rarely, however, containing actual faecal material. This stercoraceous vomitus occurs more frequently in cases of small bowel obstruction than of large. In cases of colon obstruction stercoraceous vomitus may ensue but only after considerable time, not only because of the distance to the large bowel but mainly because the ileo-cæcal valve does not allow reflux of contents from the cæcum into the ileum unless the cæcum becomes enormously distended and the valve relatively insufficient. In our series stercoraceous vomiting was present in seventy-six cases. The mortality in this class of cases was forty-four (58 per cent. of all the faecal vomitus cases).

*Distention of the abdomen* is more marked in obstruction of the large than of the small intestine. In acute intussusception it is usually absent. In case of volvulus there is considerable distention and if the large bowel is involved the volvulus may reach an enormous size. In cases of obstruction of the jejunum the distention, if present, is in the epigastrium. In obstruction of the upper ileum and in the umbilical region it is in the epigastrium. In cases of obstruction of the colon ascendens, the right side will be distended; of the colon descendens the distention develops along the sides of the abdomen. In volvulus of the sigmoid the distention may become enormous and press on the diaphragm and greatly embarrass the respiration. In our series distention was present in 305 cases. In the greatest majority it was



of moderate degree and was associated with obstruction of the small bowel. In cases where the distention was marked it was associated with obstruction of the large bowel, chiefly of the sigmoid.

*Visible peristalsis* was noted in sixty-six instances (13 per cent. of all cases). It was associated with various causes of intestinal obstruction. It presupposes a hypertrophied muscle of the intestinal wall together with an emaciated patient with thin abdominal walls.

*Palpable tumor* was discernible in ninety-four instances, more frequently in cases of intussusception.

*Auscultation* to differentiate between mechanical and paralytic ileus in the great majority of cases in our group gave normal sounds; in some decreased, and in some silent. In 101 cases they were increased.

*Obstipation, pain and vomiting* form the triad pathognomonic for intestinal obstruction. Absolute constipation may be due either to *complete mechanical obstruction* of the bowel or to *reflex nerve action*. In cases of Richter's or Littre's hernia only a small part of the intestinal wall is strangulated, the lumen remains patent but the constipation is complete. In cases of intussusception there is no absolute constipation; diarrhoea as a rule is present. In our series of cases we had obstipation in 240 cases, 43.6 per cent.; constipation (that is no faeces or flatus spontaneously, however they could be evoked by repeated enemas), 98 cases, 19.4 per cent.; irregular (alternately diarrhoea and constipation), 3 cases, 0.5 per cent.; diarrhoea, 22 cases, 4.3 per cent.; regular bowel movement, 193 cases, 4.0 per cent.; unreported, 123 cases.

*X-ray Examinations.*—Only plain plates should be taken; barium meal may block completely an otherwise incomplete obstruction and during the induction of general anaesthesia the aspiration of barium may suffocate the patient. An enema should always be given preliminary to the taking of X-ray pictures, to expel the faecal matters and the gases below the point of obstruction. X-ray pictures are of definite diagnostic value. They indicate fairly well the seat of obstruction. It may establish very early diagnosis which will be an important factor in reducing mortality.

*Sex.*—The sex in general is about equally distributed. In the Cook County Hospital series there were 259 males, 246 females. They were distributed according to age:

	Cases	Per Cent.		Cases	Per Cent.
Up to one month.....	4	0.8	Fifth decade...	97	19.4
From one month to one year	14	2.8	Sixth decade...	63	12.6
First decade.....	20	4.0	Seventh decade.	41	8.2
Second decade.....	33	6.6	Eighth decade..	13	2.6
Third decade.....	82	16.4	Ninth decade..	3	0.6
Fourth decade.....	129	25.8			

The youngest patient was twelve hours old. In this case autopsy showed the presence of a foetal mucous enterocolitis which had produced a mucolyth which blocked the colon. The oldest case was a man eighty-three years of age.

## INTESTINAL OBSTRUCTION

*Clinical type*, acute 407, subacute thirty-six, chronic fifty, unrecorded twelve.

There were several cases in which only two symptoms were prominent, namely vomitus and pain, and the bowels worked regularly. In these cases operation revealed adhesions which only partially occluded the bowel. *Diarrhœa without blood* was present in several cases in which the cæcum or lower part of the ileum was partially occluded by adhesions. *Diarrhœa with bloody stool* was present only in cases of intussusception. *Tenesmus* is a striking symptom in intussusception cases. In acute cases of intussusception it is present in 55 per cent. and in chronic in 13 per cent. (Treves.)

*Urinalysis*.—The amount of urine is usually diminished. It depends not only on the seat of obstruction, but also on the severity of strangulation and on the degree of collapse. Indicanuria is quite a frequent finding in acute obstruction of the *small bowel*.

*Temperature is usually subnormal*; however, it rises when peritoneal inflammation complicates the case. In Cornell's series of cases the average was 100° with an average high of 103° and an average low of 97°. *Pulse*: The pulse ranges from 70 to 150. *Respiration*: Respiration varies from 18 to 40. *Blood Pressure*: The average systolic pressure is 100; diastolic pressure, 88.

*Previous operations* had been performed in 279 cases (55 per cent.). It was difficult in many cases to trace exactly what operation was responsible for the obstruction because in them several operations had been performed before the obstruction took place. In fifty-two cases the type of previously performed operations was not described.

Previous appendectomy had been performed in.....	104 cases
Previous pelvic operations in.....	73 cases
Previous operations for intestinal obstruction had been performed in.....	20 cases
Previous herniotomy operations in.....	16 cases
Previous gall-bladder operations in.....	12 cases
Previous stomach operations in.....	2 cases
Previous operations (type not specified) were performed in.....	52 cases

In several of the cases of intestinal obstruction in which there was a history of previous operation for intestinal obstruction, the previous obstruction was also due to a preceding abdominal operation. In some cases intestinal obstruction followed operations performed only two weeks previously; in some as long as thirty years previously. In one case the patient had had eighteen laparotomies, of which twelve were for intestinal obstruction. Gun-shot wounds and stab wounds as a previous surgical condition were often responsible for the development of intestinal obstruction. Previous intestinal obstruction was followed by left herniotomy more frequently than the right. In cases of intestinal obstruction connected with a previous operation, the seat of obstruction was most frequently in the lower part of the ileum.

As the *cause of obstruction*, we were able to trace in 285 cases: adhesions, 205 cases; tumors, 26 cases; intussusception, 22 cases; volvulus, 19

cases; incarcerated external hernia, 16 cases; internal hernia (in internal fossa), 2 cases; impaction (foreign bodies) (fæces), 6 cases; diaphragmatic hernia, 1 case.

*The seat of obstruction was:* in the duodenum, 2 cases; duodeno-jejunal junction, 1 case; jejunum, 6 cases; ileum, 145 cases; small bowels (exact place not specified), 58 cases; large bowels (exact place not specified), 11 cases; cæcum, 9 cases; ascending colon, 4 cases; descending colon, 3 cases; sigmoid, 12 cases; rectosigmoid, 2 cases; rectum, 6 cases.

The bowel was *gangrenous* in 56 cases. The bowel was not gangrenous in 163 cases. The rest are not specified. The relative frequency of gangrenous bowel was as follows:

In duodenum.....	out of	2 cases of obstr.	0 was gangr.
In duodeno-je junction.....	out of	1 case of obstr.	0 was gangr.
In jejunum.....	out of	6 cases of obstr.	3 were gangr.
In ileum.....	out of	145 cases of obstr.	16 were gangr.
In small bowels (exact place not specified).....	out of	58 cases of obstr.	18 were gangr.
In large bowels (exact place not specified).....	out of	11 cases of obstr.	1 was gangr.
In cæcum.....	out of	9 cases of obstr.	1 was gangr.
In ascending colon.....	out of	4 cases of obstr.	1 was gangr.
In descending colon.....	out of	3 cases of obstr.	1 was gangr.
In sigmoid.....	out of	12 cases of obstr.	1 was gangr.
In rectosigmoid junction.....	out of	2 cases of obstr.	0 was gangr.
In rectum.....	out of	6 cases of obstr.	0 was gangr.

In the rest of the cases, the part of the bowel which became gangrenous was not specified.

In some cases it was impossible to decide what part of the bowel (small or large) was involved, when the patient was in extremis and it was necessary to perform enterostomy as quickly as possible. Gangrene most frequently occurred in the small bowel. There were cases in which both the small and the large bowel were involved in intestinal obstruction due to adhesions between them. In some cases the wall of the bowel was changed but it was due to the fact that it was the seat of neoplastic growth and not a gangrenous bowel. The length of the gangrenous part varied from two inches to three feet.

*Intussusception* was present in twenty-two instances as follows: Ileocæcal, 8; enteric, 4; colic, 3; ileocolic, 4; retrograde (gastro-jejunostomy), 1; type not mentioned, 2. Of these ten cases were under one year of age, eight cases between one and five years, one case between five and ten years and three cases after ten years.

*Adhesions* were present in 72 per cent. of all cases, of whom 64 per cent. had been subjected to previous operation. The adhesions in the majority of cases involved the small bowel.

*Volvulus* was observed in nineteen times out of 285 operated cases, four times in the large and fifteen times in the small bowel.

*Strangulated Hernia.*—In our series of 285 operated cases, strangulated external hernia was present in sixteen and internal in three cases. Obstruc-

## INTESTINAL OBSTRUCTION

tion was due to impact of gall-stones in one case. *Obstruction due to outside pressure on the bowel* was met with in thirteen cases involving an appendicular abscess, enlarged fibroid uterus, a large hematoma, massive glands in Hodgkin's disease, retroperitoneal abscess of unknown origin. *Fæcal impaction* was present in five cases.

*Diagnosis of acute peritonitis* was frequently confused with intestinal obstruction. Pain, constipation and vomiting are common to both conditions.

However, in peritonitis the temperature is elevated and in obstruction it is usually subnormal. Pain is constant in peritonitis, rhythmic in obstruction. The patient moves as little as possible in peritonitis, lying with bent knees and hip-joints. In intestinal obstruction he is quite restless and may even try to walk. Constipation is absolute in intestinal obstruction. In peritonitis flatus or fæces may pass. Peristalsis sounds are present in obstruction and absent in peritonitis. Chills at the onset may be present in peritonitis, absence of chills speaks for intestinal obstruction. There are cases in which intestinal obstruction develops as a result of bowel paralysis due to peritonitis. Peritonitis may develop as one of the features of intestinal obstruction.

*Course and Prognosis.*—The course and the prognosis of acute intestinal obstruction depends on several factors such as: Cause of obstruction; degree of strangulation; amount of bowel involved; age of patient; method of treatment.

If the course is due to strangulation of bowel caught in an aperture or compressed by a band, the course is very rapid and nearly always terminates fatally unless surgically relieved. The average duration of non-operative days is five with eight hours as the shortest and twenty days as the longest period reported. Spontaneous cure in cases of strangulation by a band though rare is possible as shown by reported cases. In volvulus the average duration of life is six days. The severity of the course is influenced by the extent of the twist.

In intussusception the mortality in surgically untreated cases is 70 per cent. Spontaneous cure of intussusception is reported in numerous cases, the most common method of spontaneous cure being evacuation of the gangrenous intussusceptum by natural course.

*Post-operative Mortality.*—Out of the 505 cases, 196 patients died, 276 recovered, thirty-three left without consent before any operation. Out of the 196 patients who died fifty-four were not operated upon because they either refused or were moribund and died shortly after admittance. Sixty cases died within twenty-four hours after operation; fourteen cases died within forty-eight hours after operation; nineteen cases on the third day, eight on the fourth day, six on the fifth day, five on the sixth day, thirty after one week. Of those who died seventy-two were males and seventy were females. The greatest number died in the fourth and fifth decades of their lives (sixty-nine out of 142). Of the 276 cases that recovered, 130 recovered without operation. The reasons for not operating varied; some refused operation, some evidently partially obstructed yielded to medical conservative

treatment. The entire number of cases operated upon were 292, 142 of which died (a mortality of 48.6 per cent.). Out of twenty-six cases of obstruction due to carcinoma of the large bowel sixteen died (62 per cent.). Out of nineteen due to volvulus twelve died (63.2 per cent.). Of twenty-two cases due to intussusception seven died (32.0 per cent.). Of four cases of Meckel's diverticulum three died (75.0 per cent.). Traction diverticulum, two cases; one died (50.0 per cent.). Of 205 cases with adhesions sixty-eight died (33.1 per cent.); two cases due to gall-stones, both died. Time elapsed between onset and operation is probably the most important factor in influencing mortality. The sooner the patient is subjected to operation the lower is the mortality in all types of intestinal obstruction. Thus, in the cases of intussusception, in those operated upon within twenty-hour hours or less after onset the mortality was two out of ten (20 per cent.); forty-eight hours after onset one out of seven (14.3 per cent.); seventy-two hours after onset one out of two (50.0 per cent.); 120 hours after onset two out of two (100 per cent.); seven days after onset one out of one (100 per cent.). The mortality was greatly influenced by the general condition of the patient when admitted. For cases brought into the operating room in shock the prognosis was very grave.

*General Qualification of the Surgeon.*—There is hardly any field in surgery where the skill of the surgeon is as important as in dealing with acute intestinal obstruction. He is called upon to make a quick diagnosis, to proceed to immediate operation, to handle a protruding bowel skilfully, to select promptly the proper sequence of manœuvres as, *e.g.*, whether to empty the air from the bowel or to look first for the source and seat of obstruction. He must be thoroughly acquainted with the types of intestinal operation and be able to perform them quickly and skilfully.

#### SURGICAL TREATMENT OF ACUTE OBSTRUCTION

*Pre-operative Management.*—As soon as diagnosis is established, the patient should be prepared for immediate operation: 1,000–2,000 cubic centimetres of normal salt solution or 5 per cent. glucose in normal salt solution should be given subcutaneously. Part of it (500–1,000 cubic centimetres) may be given intravenously. *Gastric lavage* should always be employed, especially in cases in which *general anaesthesia* is administered.

*Type of Anaesthesia.*—Whether *local*, *spinal* or *general anaesthesia* should be administered depends on the state of the patient and on the extent of the operation. If the patient is in very bad shape and it is decided to do *enterostomy* only, then it should be done under local anaesthesia.

Whether spinal anaesthesia should ever be used in case of mechanical ileus is debatable. It is quite proper to use it in case of paralytic ileus because cases of paralytic ileus have disappeared in fifteen to twenty minutes after the administration of spinal anaesthesia, so that no surgery was necessary. However, in cases of mechanical ileus, one does not expect therapeutic action from spinal anaesthesia, and where the blood-pressure is already lowered, this further lowering of blood-pressure is very undesirable.



## INTESTINAL OBSTRUCTION

We believe that the best type of general anaesthesia is ether anaesthesia. It raises the blood-pressure and it relaxes the patient more than nitrous oxide or ethylene. This is extremely important because in these difficult operations it is easier to manipulate the bowel and have them under the surgeon's control.

The old controversy, *i.e.*, enterostomy against entero-laparotomy, a controversy which is now more than 100 years old, is not yet settled. Although the old statistical material of fifty to sixty years ago showed definitely that mortality was lower in case of enterostomy (48.7 per cent.) than in case of laparo-enterostomy (68.9 per cent.) we do not possess recent statistic material of the same quality because nowadays a great majority of surgeons are doing enterostomy only in cases in which the patients are desperately ill and for this reason recent statistics of enterostomy show an extremely high percentage of death, far higher than the mortality in cases which permit the performance of the more complicated laparo-enterostomies which give a mortality of 40 to 45 per cent.

It seems to us that after the full significance of an early operation is appreciated there is little room for improvement in the technic of enterostomy and the mortality for this type of operation will of necessity become a stationary one. However, in entero-laparotomy, there is plenty of room for technical improvement. After this is accomplished, there is a hope that the post-operative mortality in intestinal obstruction will drop considerably. We think it a correct analogy that seventy years ago the surgical mortality was just as high as the medical mortality (80 per cent.). Just because there was no hope for future improvement in medical mortality, the treatment became surgical and mortality dropped to between 40 and 45 per cent. For the same reason we believe that laparo-enterostomy will become, except in a few moribund cases, the operation of choice.

*The Operative Technic.*—A mid-line incision is best. In about 75 per cent. of all cases, the seat of obstruction can be reached through this incision and the cause of obstruction removed. Treves advised first making a two-inch mid-line incision, introducing two fingers, exploring the cavity, and finding the site of obstruction. After this is done it is necessary to decide whether the seat of obstruction can be reached and the operation performed by enlarging this incision longitudinally. If this is decided to be impossible, then the best thing to do is to catch the lips of the wound together with three or four Allis forceps and make a new incision just above the place of obstruction. The incision should be of ample size.

After the peritoneum is incised the intestines have a great tendency to protrude. The surgeon should see that the bowel is not scattered all over the patient. The best thing to do is to spread moist warm towels on both sides of the wound or still better a rubber bag before the peritoneum is incised. As soon as the intestines leave the abdominal cavity they should be wrapped in the towels or put in the rubber bag.

If the intestines are very much distended, and if it is difficult to keep

them under control, it may be advisable to puncture them in several points, let the air out, and close these puncture openings in two layers. While it is not desirable to do this and then manipulate in the abdominal cavity, trying to remove the cause of obstruction, nevertheless, in many instances, it is the only feasible method because the bowels are so distended that they obscure the field. Another reason why in some cases puncture should precede the removal of the cause is that by hard pressure on distended coils of bowels some loops may rupture.

One of the problems which confront the surgeon is to decide whether there is enough vitality preserved in the intestinal wall to allow leaving it in the abdominal cavity, or whether the bowel should be resected.

The usual guides in defining viability of the intestinal wall are: Return of normal color of the bowel. If the bowel is of normal color, or if the black-bluish color becomes red or pinkish after the bowel has been wrapped in towels moist with warm normal salt solution and left for ten to fifteen minutes.

If the bowel is gangrenous, then one of the following steps may be taken:

The bowel is resected and both ends closed blindly. Lateral intestinal anastomosis restores the continuity of the intestinal tract. (It is *contraindicated* to do end-to-end or end-to-side anastomosis in case of intestinal obstruction because the intestinal wall is usually very much attenuated and damaged, and leakage in the line of suture is very likely to occur.)

Or the bowel is resected, both ends are brought out through the same abdominal opening and attached to each other with one stitch at the mesenteric border; the abdomen is closed; the continuity is reestablished at some future time by performing the third and fourth stages of a Mikulicz's operation.

Or the gangrenous part of the bowel and a few inches of healthy bowel situated proximally to the gangrenous bowel are brought outside of the abdominal wound. The abdomen is closed. A Paul's or Mixter's glass tube is introduced into the lumen of the bowel, proximal to the gangrenous portion. A few days later all gangrenous bowel resting on the abdominal wall is cut off. At some later day the continuity of the intestinal tract is reestablished.

The various types of intestinal obstruction require, in addition to the steps common to all types of obstruction, certain individual manœuvres. In case of: *Strangulation Due to Bands*.—The band should be cut between two ligatures, because occasionally a blood-vessel may run in the band or in a ring. The surgeon should keep in mind that *two* or *even three* bands may be present and produce obstruction. If the *strangulation is due to abnormal attachment of a normally present organ (appendix, Fallopian tube)* and the patient is in bad shape, the tube or the appendix is broken from the structure to which it is attached. If the patient is not in bad shape the tube or the appendix can then be removed.

If the *strangulation is due to an attached Meckel's diverticulum* and the

## INTESTINAL OBSTRUCTION

patient is in bad condition, the diverticulum is detached from the structure in order to liberate the bowel. If the patient can stand a longer operation, the diverticulum is removed at its base and the hole in the bowel closed by suturing the lips perpendicularly to the longitudinal axis of the bowel (similar to Heineke-Mikulicz method of pyloroplasty).

*Strangulation through a mesenteric slit* is difficult to handle because there are always blood-vessels around the edge of the slit, and always danger of cutting them when the constricting ring is severed. Should the vessels be cut, the hæmorrhage has to be stopped but there is usually no impairment in viability of the bowel because of the abundant anastomoses.

When *strangulation is due to volvulus* two things have to be accomplished: *untwisting* of the bowel and evacuation of the intestinal contents. Then either closure of the opening in the intestine, or establishment of an artificial anus above the point of volvulus and measures to prevent recurrence of the volvulus: Several cases have been reported of recurrence of volvulus after the patients had been operated for this condition.

*Post-operatively*, saline or glucose infusion are given frequently. The daily amount varied from 1,000 cubic centimetres to 3,200 cubic centimetres of saline or 5 per cent. glucose. The total for the first four to five days in some cases reached 15,000 cubic centimetres of normal salt solution and 5,000 cubic centimetres of 5 per cent. glucose. The mortality was not influenced by the amount of solution given. This, however, does not prove or disprove anything because the worse the condition of the patient, the more solution was he given.

### SUMMARY

(1) The mortality of *surgically treated* cases of acute intestinal obstruction has been reduced very little in the last twenty-five years.

(2) In our series of cases it was 48.6 per cent.

(3) The high mortality is due to *late* surgical interference when the "triad" of symptoms is present. This "triad" appears late, when the patient is practically moribund.

(4) Injection of normal salt solution, glucose, *etc.*, cannot compensate for the damage of delay and does not influence appreciably the degree of mortality.

(5) The mortality will be appreciably reduced only by early operation and this will be possible only when early diagnoses are made.

(6) An early diagnosis is possible only by taking flat X-ray films routinely. A "herring-bone" appearance shows the earliest stage of obstruction, a "stepladder" appearance shows a more developed process and "fluid-levels" show the well-advanced intestinal obstruction.

(7) In every post-operative abdominal case in which intermittent abdominal pain arises, it is advisable *immediately* to take a flat X-ray film by a portable apparatus and not wait until the grave "triad" appears.

## ACUTE INTESTINAL OBSTRUCTION

A COMPARATIVE STUDY OF 511 CASES, WITH SPECIAL REFERENCE TO THE  
LOWERED MORTALITY ACHIEVED BY MODERN METHODS OF THERAPY

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SERVICES OF THE NEW ORLEANS CHARITY HOSPITAL, 1930-1932.

IN 1929, C. Jeff Miller<sup>1</sup> published from two New Orleans hospitals a series of 343 cases of acute intestinal obstruction with a mortality of 60.9 per cent., thereby demonstrating again a fact with which all writers on the subject are in entire accord, that the death rate in this disease is frequently very much higher than it is sometimes assumed to be. This discrepancy, as the author points out, is not hard to explain; indeed, it is inevitable, if cases of acute, complete obstruction, which is always potentially fatal, are not differentiated from cases of partial, incomplete obstruction, in which the pathology is, as a rule, inherently much less serious.

Doctor Miller's instructive paper has undoubtedly exerted a profound effect upon the general management of intestinal obstruction. It has been widely abstracted and quoted, as it deserved to be, and it is our personal opinion that here in New Orleans, whence the report emanated, it has had a most salutary effect in forcing upon the surgeons who handle the condition, particularly on the emergency services of the public hospital, a vivid realization of the true facts of this very deadly disease.

It was with the idea of contrasting the facts of a later period with the facts presented by Doctor Miller for an earlier period that we began this study, the basis for which is 340 cases of acute mechanical ileus treated at Charity Hospital in New Orleans from 1930 through 1932. Through the courtesy of Doctor Miller we have had access to his original material, and for comparison with the later three-year period we have chosen from his study the five-year period ending in 1927, during which 171 cases were treated at the same institution. This gives us two evidently parallel series of which a fair comparison can be made.

Both series include only cases of acute, complete obstruction which were submitted to surgical treatment. No attempt has been made to analyze medical cases, for obvious reasons. The patients who recovered without operation undoubtedly had obstructions which were not complete. Those who died simply furnished additional corroboration of the fact that in intestinal obstruction without surgery there can be no salvation, though perhaps, since Wangensteen has popularized Robertson Ward's method of decompression, that statement no longer holds without qualification.

<sup>1</sup> Miller, C. J.: Study of Three Hundred Forty-three Surgical Cases of Intestinal Obstruction. *ANNALS OF SURGERY*, vol. 89, p. 91, 1929.

## ACUTE INTESTINAL OBSTRUCTION

The fact that 340 cases were treated over the three-year period in our own study, against only 171 cases over the five-year period of the earlier study, does not indicate, as it might seem, any marked increase in the incidence of the disease. The increase, for all practical purposes, may be set down as proportionate to the increase in the hospital population, and that increase, in turn, can be traced partly to the increase in the population of the community which the hospital serves and even more to the increase in the number of persons it is called upon to serve in these days of financial depression. Many of these patients, it must be granted, are of the social level which formerly did not seek its medical attention in public institutions, though that circumstance has little effect, we believe, upon the statistics which we are presenting; private patients, as every published series shows, are all too frequently guilty of the same reckless disregard of "inaugural symptoms" as the most ignorant of indigent patients could exhibit.

It may be taken for granted that the run of cases in the same institution is likely, year in and year out, to be about the same, and in a disease of this sort there seems no reason for assuming that the condition is any more serious in one year than in another. Furthermore, while the difficulties, let alone the invidiousness, of such a comparison are evident, it is fair to point out that the patients in both series were operated upon by surgeons of approximately the same level of skill and dexterity. The 1923-1927 group was handled by five surgeons, the 1930-1932 group by eight, but all of them were graduates of the same institution, and all of them, so far as the inescapable personal equation permits such a generalization, had been subjected to the same influences and had had the same amount of experience in their internships and in their surgical residencies.

Finally, as would be expected, the age incidence is practically the same in both series, the male incidence, as in most reported series, is slightly higher than the female, and the racial incidence is about in proportion in both series to the white and Negro hospital admissions.

We have purposely emphasized the fairness of comparing these two series by pointing out their fundamental similarities because only in these circumstances are they alike. The end-results are entirely different, the mortality of the later series being less than half as high as the mortality of the earlier series. Etiologically, as Table I shows, the differences are slight, about the same proportion of each type of case appearing in each series. That means, then, that the proportion of high and low obstructions is practically the same in both series, and that the incidence of high obstruction, which is always more serious, other things being equal, than low obstruction, cannot be invoked to explain the difference in the mortality rate. We are driven, therefore, to some other explanation or to some other explanations of the fact that in the early series of 171 cases covering the period from 1923 through 1927 the death rate was 70.7 per cent., more than twice as high as the death rate of 31.7 per cent. for the 340 cases covering the period from 1930 through 1932.



## MOSS AND McFETRIDGE

TABLE I  
*Etiological Factors*

Cause of Obstruction	Number of Cases		Percentage	
	1923-1927	1930-1932	1923-1927	1930-1932
Herniae.....	53	157	31.0	46.2
Adhesions and bands.....	46	91	26.9	26.7
Intussusception.....	20	18	11.6	5.3
Volvulus.....	18	29	10.5	8.5
Malignancy.....	9	4	5.2	1.2
Peritonitis.....	6	16	3.5	4.7
Foreign-body occlusion.....		10		2.9
Diverticulitis.....	2	2	1.2	0.6
Congenital occlusion.....		1		0.3
Diagnosis undetermined.....	17	12	9.9	3.5

One explanation immediately presents itself. Generally speaking, and of course with reservations, the duration of any acute intra-abdominal disease affords the first clue to its mortality, and that generalization holds here. The figures for both groups of cases prove the truth of Van Beuren's aphorism, that the longer a patient with intestinal obstruction lives before operation, the sooner he dies after it. In the Miller series of cases (in the 155 cases in which the time was stated), the average duration of illness prior to admission was 42.7 hours, whereas in our own series it fell to thirty-five hours. Looking at it from another standpoint, in the Miller series 49 per cent. of the patients had been ill more than ninety-six hours when they sought relief, against only 27.6 per cent. in our own series. In partial explanation of the duration of the illness, at least in some cases in both series, it should be interpolated that the New Orleans Charity Hospital serves not only New Orleans, but some four-fifths of Louisiana also, and that, even though the distances within the state are not excessive, patients must sometimes travel for hours to reach the institution.

Why the average duration of illness prior to admission has been reduced, or why the number of patients whose illness was of long duration is so much smaller in the later series, we cannot explain. Perhaps, thanks to public propaganda concerning the risk of ignoring intra-abdominal pain and the dangers of home treatment for it, the public is actually becoming more intelligent. Perhaps the medical profession is becoming more alert in both the suspicion and the diagnosis of acute abdominal disease, more "obstruction-minded," as Wangenstein puts it. Whatever the reason, the fact remains that the duration of the obstruction prior to hospitalization is decidedly less in the series we are reporting than it was in Miller's series, and in that fact lies the first explanation of the materially reduced mortality in the later group of cases.

Varying etiological factors, as we have already intimated and as Table II shows, play no special part in the lower death-rate in our own series. In malignancy, as Miller pointed out in his report, many indigent patients who had undergone colostomy remained in the hospital after their surgical

## ACUTE INTESTINAL OBSTRUCTION

recovery until they were carried off by the natural processes of their disease, because they had literally nowhere else to go. That situation holds in our own series also, but to a lesser degree, for a more active social service department, in combination with an increased demand for bed space for patients for whom something can be done, has seen to it that many such patients in the later group were returned to the care of their communities or were provided for elsewhere, and the hospital death-rate is proportionately lower. The very striking reduction in the mortality of strangulated hernia, from 77.3 per cent. to 22.3 per cent., is apparently to be explained on the basis of earlier treatment. In many of the cases in both series the patients were men advanced in years, in whom cardiorenal complications undoubtedly played a part in such fatalities as occurred, or were obese women, in whom umbilical hernia is always a serious event.

TABLE II  
*Mortality in Relation to Etiological Factors*

Cause of Obstruction	Mortality 1923-1927	Mortality 1930-1932
Herniæ .....	77.3	22.3
Adhesions and bands.....	65.2	35.1
Intussusception.....	55.0	27.7
Volvulus.....	72.2	51.7
Malignancy.....	77.7	50.0
Peritonitis.....	66.6	50.0
Foreign-body occlusion.....		40.0
Diverticulitis.....	50.0	
Congenital occlusion.....		100.0
Diagnosis undetermined.....	82.4	50.0

The surgical procedures undertaken we have not studied in any great detail. For one thing, it is manifestly unfair to condemn any operation without a more accurate knowledge of conditions than can be gained by a perusal of the history after the event. For another, even surgeons of the same experience and training differ in their opinion of the worth of certain procedures under certain circumstances, as well as in their technical ability to perform them. One or two facts, however, are outstanding. In the later series enterostomy was performed proportionately less frequently than in the early series because, since the patients were seen promptly, it was less often necessary. Furthermore, when it was used, it was not the procedure of desperation, the last resort, that it so often was in the earlier series. It was the procedure of deliberation which it should be, and from which, when it is so employed, good results can be expected, not the *ante-mortem* act which it always is when it is employed after paralysis has affected most of the bowel wall.

Another point should also be enlarged upon. Comparing the series, case for case, and estimating the risk as fairly as a risk can be estimated on paper, it was evident always that the less surgery was done, the better the

result was likely to be. It was equally evident, too, that the more radical was the surgery, the more inevitable was the fatality. In Miller's series of 171 cases, radical operation (by which is meant resection with immediate anastomosis) was done twenty-eight times with twenty-six deaths. In our own series of 340 cases that procedure was carried out only fourteen times, with only seven deaths. A mortality of 50 per cent. is still a frightful mortality and by no means to be condoned, but it is quite evident that the far smaller proportion of cases treated by radical measures in the later series explains at least part of the reduction in the mortality generally, while the reduction of the mortality for that particular procedure from almost 93 per cent. to 50 per cent. proves that the cases in which it was done were certainly more carefully selected.

From that fact can be drawn another conclusion, that the conception of intestinal obstruction has changed in a striking way with the passage of even the few years that have elapsed between Miller's study and our own. Any disease the very name of which implies a blockage of or interruption to the fecal current must necessarily be a disease in which mechanical problems are very important problems, but we have come more and more to believe that such considerations are, after all, relatively minor ones as compared to the sequelæ which follow in their wake. Patients suffering from intestinal obstruction die from many terminal complications, it is true, but all of them die of those complications in association with one overwhelming pathological change, a perversion of the normal blood chemistry. That change, in the minds of the surgeons of this era, is the single consideration that overshadows all others in the management of intestinal obstruction, and the comprehension of its importance is a relatively new thing.

It is quite true that, as early as 1912, Hartwell and Hognuet, in the course of their experimental work in high intestinal obstruction in dogs, pointed out the part played by a disturbed chloride balance, and that the host of investigators that succeeded them, among whom Haden and Orr are outstanding, continued their experimental studies, corroborating their results and adducing new facts, but the correlation between the clinic and the laboratory is notoriously slow, and the mere publication of experimental facts, even with their clinical application, by no means implies their general adoption. The importance of a disturbed blood chemistry in intestinal obstruction has been recognized for many years, but only very recently has that realization been generally translated into action, only quite recently have routine methods of correction been introduced. The sequence of events in intestinal obstruction, as Haden and Orr have pointed out, has always been mechanical obstruction, dehydration, starvation and toxæmia, but the importance of all the links in the chain has been a late realization, as is evident in the comparison of these two series of cases.

In the early group there was in many instances an attempt to rehabilitate the patient and to prepare him for surgery, but it was always a more or less half-hearted attempt. The chief idea was to get him to the operating

## ACUTE INTESTINAL OBSTRUCTION

room as rapidly as he could be transported thither. Infusions were frequently given, but they were usually given empirically, sometimes of glucose and insulin, sometimes of normal saline solution, practically never with reference to the actual conditions present.

In 1929, however, the clinical application of long and patient years of experimental work reached its climax in the publication of the formula of Hartman's buffer solution. That solution takes into account these facts: that the body tissues need all the normal body salts of which they have been deprived by the pathological process of intestinal obstruction; that while some patients are suffering from alkalosis, others, as McIver and Gamble, and Gatch have stressed repeatedly, are suffering from acidosis; and that provision must be made to combat either type of perverted blood chemistry. It was about this time, too, that Haden and Orr, whose work was quickly confirmed by other investigators, pointed out that those patients in whom the blood chlorides were seriously disturbed received no benefit whatsoever, except from the standpoint of fluid balance, from the administration in any fashion of normal salt solution, and that what they needed was the restoration of their lost chlorides in the form of hypertonic salt solution. In other words, during the period that intervened between Miller's study and our own, intestinal obstruction to the surgeon became less of a mechanical and more of a chemical problem, and surgery became only one step of the process that was designed to save the life of the individual suffering from it.

The idea, then, in the later series of cases was not to get the patient to the operating table as fast as possible, but to get him there in the best condition possible. The importance of prompt mechanical correction of the intestinal pathology was realized no less than in the earlier series, but to that realization was added the comprehension that mechanical correction without, in addition, what we may term constitutional correction, could be of value only in a limited number of cases, in those rare instances in which the diagnosis is made so promptly and surgery is undertaken with so little delay that changes in the blood chemistry are slight or do not enter the picture at all.

Certain treatment was routine in all of the cases we are reporting. The relief of the shock that is always an accompaniment of intestinal obstruction in any but the very early stages was achieved by the elevation of the foot of the bed, the application of external heat, and the administration of morphine in large doses. Such measures, it is universally granted, are as helpful to the patient who is in shock from intestinal obstruction as to the patient whose shock is the result of accidental or surgical trauma.

Gastric lavage, just as in the early series, was routine, not only to keep the patient from developing an aspiration pneumonia or from drowning in his own secretions, particularly if a general anaesthetic were contemplated, but also to rid the stomach and the upper intestine of the accumulated contents which are increasingly toxic in proportion to the level at which the obstruction has occurred. In no case in either series was the Wangensteen

method of decompression used, but it will certainly, in the future, play an important part in pre-operative preparation, even if it does not—many of us are afraid to hope for too much—avoid surgery altogether in many instances.

Lost fluids were replaced either by hypodermoclysis or by infusion, usually the latter, Hartman's solution being used unless an excessive loss of chlorides demanded the administration of hypertonic salt solution. With modern technic and in a properly equipped laboratory, such as is available in any large hospital, blood-chemistry studies can be done without undue loss of time, and are sufficiently helpful in indicating the line of treatment necessary to justify the slight delay they involve, particularly since, as we have pointed out, the selection of the optimum time for surgery on the rehabilitated patient serves his interests far better than does immediate surgery without such rehabilitation.

The outstanding fact in these cases seemed to be the individualization of the patient. Every patient was carefully observed at frequent, regular intervals by the surgeon in charge of the case. His every reaction, his every response to treatment, was noted and evaluated, with the idea of bringing him to the operating table as promptly as his condition warranted, prepared for the further ordeal that is inevitable in the surgery necessary to afford relief. There is no doubt in our minds that the method of pre-operative preparation we have outlined, with its emphasis on the constitutional rather than the local changes produced by the mechanical blockage of the intestines, is perhaps the most important single therapeutic factor contributing to the reduction of the mortality in the three-year period we have studied.

Miller, in his study of 343 cases, arrived at the conclusion—on what seems, it must be granted, indisputable evidence—that the anaesthesia of choice is some form of general anaesthesia. No matter from what aspect the figures are considered, he points out, general anaesthesia seems to have the best of the bargain, and if it be granted, as we have already granted, that the cases which enter the hospital over any two given periods of time are likely to be of equal gravity, he seems to have proved his thesis. On the other hand, in the light of our own series, his conclusions are open to question.

The trends evidenced by an analysis of the two series of cases are exceedingly interesting. In Miller's series (Table III) local analgesia was used in 35.6 per cent. of the 171 cases, with a mortality of 98.3 per cent., against its use in 7.3 per cent. of our 340 cases, with a mortality of 76 per cent. In Miller's series spinal analgesia was used in 19.8 per cent. of the cases, with a mortality of 70.5 per cent., against its use in 70 per cent. of our cases, with a mortality of 22.2 per cent. In Miller's series general anaesthesia was used in 41.5 per cent. of the cases, with a mortality of 46.4 per cent., against its use in 22.6 per cent. of our cases, with a mortality of 42.8 per cent.

How is one to interpret these figures? The surgeons who handled the cases in the period covered by our study had, as we have pointed out, an ad-



# ACUTE INTESTINAL OBSTRUCTION

TABLE III

## *Mortality in Relation to Anæsthesia*

Anæsthesia	Number of Cases		Proportion of Cases		Mortality	
	1923-1927	1930-1932	1923-1927	1930-1932	1923-1927	1930-1932
Local.....	61	25	35.6	7.3	98.3	76.0
Spinal.....	34	238	19.8	70.0	70.5	22.2
General.....	71	77	41.5	22.6	46.4	42.8

vantage over the surgeons who handled the cases in Miller's report in that they saw the patients earlier, but on that basis one would expect a consistent drop in the mortality for each anæsthetic, not a reversal of the mortality, which is what has really happened. Some other explanation clearly must be sought.

The very high mortality in each group for local analgesia presents no difficulty. It is reasonable to assume that it was reserved for the very bad risk patients, some of whom were practically moribund when they were placed on the operating table, others of whom were submitted to surgery not with any hope of relief, but merely not to deprive them of their gambler's chance of life, even though all the odds were against success. Table IV, which shows the time of death in relation to the anæsthesia, supports that point of view.

TABLE IV

## *Time of Death in Relation to Anæsthesia*

Time of Death	Local		General		Spinal	
	1923-1927	1930-1932	1923-1927	1930-1932	1923-1927	1930-1932
On table.....	4.9		1.4	7.7	5.8	2.5
1-12 hours.....	34.4	16.0	14.0	5.2	23.2	1.2
12-24 hours.....	21.3	16.0	8.4	11.7	11.6	2.9
24-48 hours.....	11.4	12.0	8.4	5.2	8.8	4.2
48-72 hours.....	8.1	12.0	2.8	2.6	5.8	2.1
After 72 hours.....	18.0	24.0	11.2	14.2	14.7	8.8

Our own interpretation of the proportion of spinal and general anæsthesia used in the two series, and of the mortality which accompanied each one, is this: In the earlier series spinal analgesia was used chiefly for bad risk patients, patients who were in better condition than those for whom local was used, but who were assumed to be unfitted to withstand a general anæsthetic, whereas in the later series the use of spinal analgesia became more and more routine, for good and bad risk patients alike. An analysis of the anæsthetic agents by years, we might add, supports that hypothesis. Moreover, it may fairly be concluded, though it must be admitted that the conclusion is supported by no statistical facts, that general anæsthesia, while it was used in the first series from an honest conviction that it was in the better interests of the patients, was frequently used in the second merely in deference to public opinion. Spinal analgesia, it must be remembered, is subject at intervals to a great deal of criticism, some of which it must be granted is entirely deserved. One of those periods coincided with the

period at which our study begins, and our inference is that the use of spinal analgesia would have been decidedly greater except for the fear of this criticism, and for the additional fear that some patients might succumb on the operating table, as all too many patients with this disease do, and that their deaths might be charged to the anæsthetic rather than to the pathological process. To withhold a type of anæsthesia which one feels is best for the patient for any such reason as this is, of course, fallacious reasoning, but the facts, it seems to us, warrant the deduction.

One final explanation of the reduced mortality in our series must be mentioned: the increasing use of the X-ray for the early diagnosis of intestinal obstruction. The method has been long known; German radiologists have employed it since 1911, and isolated reports have appeared in American medical literature for almost as long a time. But as in the application of chemical studies, so here, the publication of a method, however valuable it may be, and its adoption are two very different considerations. It was not until the late 'twenties that the X-ray was seriously advocated as a diagnostic aid in intestinal obstruction, and the result is that in Miller's series it was not used, as far as we can discover, in a single case, whereas in our own series it was used in 108, nearly a third of the total number. The typical step-ladder appearance of the fluid and gas levels in intestinal obstruction establishes the diagnosis absolutely, it is now recognized, and the use of this method in the cases we have studied undoubtedly played an important part in dictating the treatment, both preliminary and surgical.

#### SUMMARY AND CONCLUSIONS

The mortality of intestinal obstruction in Charity Hospital has been reduced more than half within a period of ten years by the use of the proper pre-operative preparation, chiefly directed toward the correction of perverted blood chemistry, by the restriction of surgical procedures to those directed only toward the relief of obstruction, by the increasing use of spinal analgesia for all patients, by the use of the X-ray as a diagnostic measure, and by the shortening of the interval between the onset of symptoms and admission to the hospital, an improvement which is clearly evident even though its occurrence cannot be explained.

The reduction of the mortality from 70.7 per cent. in the five-year period from 1923 through 1927 to 31.7 per cent. in the three-year period from 1930 through 1932 should be a matter of congratulation to the surgeons who treated the patients in the later series in the light of new discoveries and with a new conception of the disease. But a death-rate of 31.7 per cent. is still too high for any illness in which such a mortality is not absolutely inevitable, as it is not in intestinal obstruction, and it is to be hoped that the addition of Wangensteen's decompression method, both as an independent procedure and as an adjuvant to surgical measures, will still further reduce even this greatly improved mortality.

## PERISTALSIS AND PERITONITIS \*

BY HENRY P. BROWN, JR., M.D.

OF PHILADELPHIA, PA.

WITH such a voluminous literature relating to the various aspects of peritonitis, it is indeed with a sense of apology that the writer presumes to add to it, even if only in a very minor degree. I wish to discuss briefly the relationship of intestinal peristalsis to peritonitis, a factor which, while mentioned in most text-books of surgery, has usually not allotted to it the importance which the writer believes it deserves.

Why is it advised to withhold nourishment by mouth in the presence of peritonitis, arising, for example, from a ruptured appendix? For some time, I have asked this question of the students in the surgical section of the Graduate School of Medicine of the University of Pennsylvania, and the answer has invariably been to the effect that by so doing it is hoped to decrease intestinal peristalsis, thus preventing the further spread of the infection, and enable it to be walled off or localized by the peritoneum.

It may be fairly assumed that these students, about twenty-four in number each year, coming from all parts of the country, express the attitude on this phase of peritonitis as taught in most of the medical schools, and therefore the one adopted by most of the leading surgeons. It is, therefore, with considerable trepidation that I express any opinion which would tend to be at variance with an idea which is so widely accepted.

The question immediately arises as to how much, if any, does peristalsis tend to spread peritoneal infection which, to my mind, is of much less importance than what effect does intestinal obstruction have upon a person suffering with peritonitis, for I think it will be admitted that the symptoms resulting from a distended intestine, paralyzed from peritonitis, are analogous to those of intestinal obstruction, the severity of each being a matter of degree.

To answer the first part of the question, namely, the spreading of infection by peristalsis and the walling off of the infection. It has been contended by numerous observers that if the source of the infection be removed, *e.g.*, a perforated appendix, and the resistive forces of the body be not overwhelmed before this is accomplished, many of these abdomens can be closed without drainage, the peritoneum being quite capable of handling the infected material within the abdomen. It has been further recently stated that the peritoneum of the upper abdomen is quite as capable as that of the lower in dealing with this type of invasion.

It is the writer's belief that what really occurs under such circumstances is that in those cases in which the body resistance overcomes the infection, most of this foreign material is absorbed, except possibly at the original source

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\* Read before the Philadelphia Academy of Surgery, May 1, 1933.

of infection (for example, appendix), where a truce is called between infective and resistive forces, with the compromise formation of an abscess. Were the source of infection in the upper instead of the lower abdomen, for example, a high lying ruptured appendix, when the peritoneum had walled off the infection it would probably be found that the main abscess was at the site of the original focus of invasion.

The presence of secondary or residual abscesses which one finds is merely an indication that the defensive power of the peritoneum, for the time being, has been unable to eradicate the infection in this particular region. The point which I am trying to elucidate is that, providing the source of infection is eliminated, one part of the peritoneum is just as capable of handling infection as any other part, or nearly so, and therefore the mere shifting of infectious material from one area of the abdomen to another is, for all practical purposes, immaterial, even if we assume that peristalsis can shift infection to any considerable extent.

Anyone who has observed peristalsis in an abdomen opened under spinal anaesthesia knows that there is very little change in the relative position of the intestinal coils during peristalsis. The action may perhaps be very crudely compared with the motion of a boat on a becalmed sea, in which the ground swell raises and lowers the boat with each wave, but neither the boat nor water change their relative positions. In a similar fashion, the infected material representing the boat and the intestine the water, it is the writer's belief that peristalsis has very little effect upon the dissemination of infection within the abdomen, but it does have a considerable influence upon changing the position of the intestinal contents.

Following the law of gravity, infected fluid within the abdomen will tend to collect in dependent positions, but it seems that the action of peristalsis is of but little consequence in this respect. It would therefore appear that the rationale of withholding nourishment by mouth in the presence of peritonitis is not that we are afraid of increasing peristalsis, but rather that by the introduction of food into an intestine already so impaired by toxæmia, as far as its normal physiological function is concerned that the power of digestion or the normal handling of such food is lost for the time being, such food, acting as an irritant, causes fermentation and distention of the intestine with further impairment of intestinal function, thus increasing the degree of intestinal obstruction (ileus) and adding to the burden to be met by the resistive forces of the body.

The important question in the treatment of peritonitis is whether the resistive forces of the patient are able to overcome the toxic manifestations of infection. Should the invasive forces be greater than those of the body defense, the next step in the picture is the progressive paralysis, one of degree as well as extent, of the intestinal tract, due to toxic action on those factors which induce and maintain peristalsis.

When this condition of paralysis has progressed far enough, the defensive forces of the body, in addition to combating the effects of peritonitis, must

## PERISTALSIS AND PERITONITIS

also face those arising from intestinal obstruction of varying degree. I believe that the question as to what causes the toxic manifestations in intestinal obstruction is still unanswered, in spite of the many theories and observations on the subject.

It seems reasonable to assume that the intestinal paralysis seen in peritonitis is a toxic manifestation and in no sense a defensive action on the part of the body. My reason for this statement is that I have never observed nor heard of a case of peritonitis from colon bacillus infection resulting fatally in which peristalsis was maintained up till the time of death, for in such cases the silent distended abdomen, with its often foreboding prognosis, is unfortunately only too familiar to all of us. On the contrary, we know what a welcome prognostic sign is the first natural stool in such a case, and how, if peristalsis can be maintained, it is practically always an indication that the invasive forces of the infection have been overcome and, barring complications, as far as the peritonitis is concerned, the prognosis is decidedly favorable.

In view of the fact that nearly every one will agree that toxic (not mechanical) ileus or obstruction with its deleterious effects is incompatible with active peristalsis, it would seem that by maintaining the latter in the presence of infection within the peritoneal cavity, one of the most important, and often the overwhelming, results of peritoneal invasion could be eliminated, leaving the peritoneum and body forces free to deal with the infection of the peritoneum, *per se*.

If the foregoing hypothesis be true, in a case of peritonitis from, for example, a ruptured appendix, and in this discussion I am not considering those cases of diffuse peritonitis either blood- or lymph-borne, such as streptococcus or pneumococcus, *etc.*, after removal of the focus of infection and the establishment of suitable abdominal drainage, if one advocates drainage under such circumstances, in addition to the usual methods of treatment such as adequate amounts of fluid by vein and hypodermoclysis, abdominal stapes, aspiration of gastric accumulation as indicated, and other supportive measures, it is suggested that at the first evidence of abdominal distention and hence beginning toxic intestinal paralysis, pituitary extract or some other efficacious peristaltic stimulant be administered in an appropriate manner, either by vein or hypodermically, in sufficient amount and at such intervals that peristalsis will be maintained and thus an effort be made to prevent the development of intestinal paralysis.

In advanced post-operative cases of peritonitis in which the condition has progressed to the stage of silent abdomen, marked distention, vomiting, *etc.*, many surgeons advocate establishing a high jejunostomy in the hope that by draining the toxic contents of the upper intestinal tract and partially relieving distention, the patient may be somewhat relieved of the effort of combating the added burden imposed by the absorption (?) of injurious products from this region.

In such a procedure, aside from draining the immediate segment of bowel in which the tube is placed, all subsequent drainage must necessarily be due to



peristalsis, a condition which the surgeon welcomes, as he knows it will tend to relieve the toxic manifestations partially arising from the paralyzed intestines. Under such circumstances he pays little heed to the danger of further spread of peritonitis which may be induced by peristalsis.

Should the above be true, surely it would be logical to take advantage of the peristaltic action of the bowel in the early stages of peritonitis rather than adopt it as a last resort in an effort to save the patient.

Illustrative of the foregoing procedure, we may briefly cite the following two cases, representative of spreading and localized peritonitis.

CASE I.—E. W., a white man of fifty-seven, was admitted to Doctor Hodge's service at the Presbyterian Hospital November 28, 1932, with the complaint of pain in the left lower abdomen and vomiting. He stated that for the past twenty years he has had recurrent attacks of vomiting, with and without abdominal pain, the latter usually left-sided, being less severe than on admission. His most recent attack began November 26, with pain in the left lower abdomen; was somewhat relieved the next day, but was again worse on the day of admission, when the pain for the first time was present on the right side. He was acutely ill, quite uncomfortable, but not suffering severe abdominal pain, and was otherwise essentially negative aside from his abdominal findings. There was considerable tenderness with much muscle guarding over the entire abdomen, more marked on the right side, and there was marked rebound tenderness over the entire abdomen. Temperature, pulse and respirations 101.4°, 100 and 26. Leucocytes 23,000. Urine showed a trace of albumen, a few hyaline casts and a specific gravity of 1030.

At operation, performed shortly after his admission, a small amount of cloudy non-odorous fluid was present within the abdomen. A localized mass in the lower abdomen, to the right of the mid-line, contained a gangrenous appendix within an abscess. About two ounces of colon pus were aspirated and the appendix removed. The tip of the appendix had extended across to the left of the mid-line of the body, probably accounting for the pain on the left side. A cigarette drain was placed in the abscess cavity and one extending into the pelvis. He was given the usual post-operative treatment for peritonitis as outlined above, and aside from considerable vomiting, his condition next day was fairly satisfactory.

On the second post-operative day there was a rather profuse discharge of thin pus with a colon odor. His abdomen was quite distended and very tender, and the pelvic drain was removed. An effectual enema was given, with the passage of considerable flatus. A large amount of greenish fluid was aspirated from his stomach. Temperature was 99°, pulse 96, and respirations 28. Next day the Jutte tube removed a moderate amount of gastric accumulation, and his entire abdomen was acutely tender and distended. Fluids continued to be freely administered by vein and hypodermoclysis.

December 3, the fifth day after operation, in spite of passing some flatus, he was still considerably distended, the remaining drain was removed; abdominal tenderness had somewhat decreased. Abdominal stupes and enemas failed to relieve his distention. Next day he was given one ampule of pituitrin every three hours, for three doses with the passage of considerable flatus, affording relief from his distention.

From December 7 till December 10 he was given one ampule of pituitrin every three hours, day and night, for his distention. After receiving each ampule, he would pass large amounts of flatus, with great relief, only to have it re-accumulate within three hours. At the end of this time, he was able to pass gas freely without the pituitrin and his abdomen became soft and scaphoid.

December 18, twenty days after operation, he was still draining profusely from his incision and he was having normal stools daily without enemas. From this point the discharge rapidly diminished and he was discharged as cured January 23, fifty-six days

## PERISTALSIS AND PERITONITIS

after operation. At no time did he show any ill effects from the pituitrin, and it was most encouraging to see how his condition improved with the relief of his distention.

We believe that this patient developed a post-operative spreading peritonitis on the second or third post-operative day, as pressure on almost any part of his abdomen caused a marked increase in the drainage from his wound, and that the prevention of symptoms of intestinal obstruction from paralysis of the bowel was an important factor in the favorable outcome of this particular case.

CASE II.—An instance of peritonitis of a lesser degree occurred in a woman of sixty-three admitted to Doctor Lee's service at the Pennsylvania Hospital, in whom an appendiceal abscess, well walled off by the intestine and omentum, was drained, the appendix not being removed. The history, operative findings and progress in this instance indicated that the infected area was localized from the onset and had not involved the general peritoneal cavity.

At the first sign of post-operative distention, on the third day, she was given half an ampule of pituitrin, followed by a soapsuds enema, with the passage of flatus and the relief of her distention. In this case, distention recurred about once in twenty-four hours, and a half ampule of pituitrin per day, over a period of four or five days, relieved the distress and kept her quite comfortable. The drainage followed the usual course of a localized infection of the peritoneum, she remained quite comfortable, and did not develop any evidence of a fecal fistula, in spite of the appendix not having been removed, and the administration of pituitrin.

In the more advanced stages of peritonitis, it of course being assumed that alkalosis and allied conditions are recognized and adequately treated, the response of the intestine to pituitrin may possibly serve as an indication of the degree to which its peristaltic power has been paralyzed, for when this response has been completely lost in the presence of a powerful stimulant, it is indeed questionable whether by jejunostomy one can hope to drain a sufficient area to render this procedure efficacious.

How much better it would be if this post-operative condition could be anticipated and we were able to avoid this degree of toxæmia by preventing its occurrence.

It is, of course, appreciated that many cases of peritonitis will die in spite of any treatment, but, as was stated at the outset, my object in presenting a discussion of the subject is the hope that those of us dealing with this type of infection will perhaps appreciate that peristalsis can be of inestimable value in aiding the body in its effort to combat peritonitis when caused by the above-mentioned conditions, and that one should give it due consideration in the treatment of these cases.

## GASTRO-DUODENAL RESECTION AS A SYSTEMATIC TREATMENT OF DUODENAL ULCER

By ANGELO CHIASSERINI, M.D.

OF ROME, ITALY

SURGEON IN THE OSPEDALE DEL LITTORIO ROME

WHEN in 1928 I started my work as a surgeon of the Third Division in the Hospital of Venice I used to treat duodenal ulcer and pyloric duodenal stenosis with gastroenterostomy, reserving resection for gastric and jejunal ulcer.

But very soon afterwards I began to do resections also for duodenal ulcers and its complications (stenosis, hæmorrhage, perforations) more and more frequently as the time went on; so that by the beginning of 1930 I had limited the use of gastroenterostomy, in the treatment of duodenal ulcer, to such cases which, on account of very poor general conditions or the impaired function of some important organ (especially the heart and the liver), did not seem fit for a complicated operation like duodeno-gastric resection. Only in exceptional cases local conditions appeared such as to contra-indicate a radical operation.

This change from conservative to radical operations is demonstrated by the following figures: from June, 1928, to June, 1931, (3d surgical Division-Venice) 79 resections and 53 gastroenterostomies were performed (besides a few gastroduodenostomies and excisions of the anterior half of the pyloric sphincter). Most of the gastroenterostomies were done for duodenal ulcer; while of the 79 resections 34 were done for duodenal ulcer, 24 for gastric ulcer, six for gastritis, 11 for jejunal ulcer or persistence of the primitive ulcer, or gastritis, after gastroenterostomy; four for perforated duodenal ulcer.

From January, 1932, to February, 1934, (Padiglione Flajani-Ospedale del Littorio in Rome) 117 resections were done by me and my assistants, and only two gastroenterostomies; four gastroduodenostomies; three anterior excisions of the pyloric sphincter.

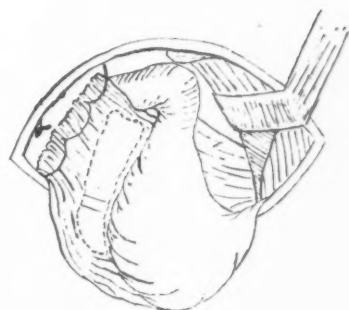
Of the 117 resections 89 were done for duodenal ulcer (in seven cases the ulcer was perforated); eighteen for gastric ulcer; seven for post-operative jejunal ulcer; three for gastritis.

Since January, 1933, all cases of ulcer (gastric-duodenal-jejunal) have been treated with resection; while this has been completely dismissed for gastritis.

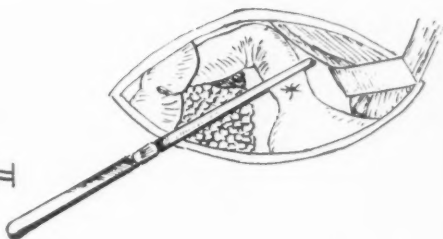
This means that the systematic radical treatment formerly applied to gastric and jejunal ulcer has been extended also to duodenal ulcer.

Theoretical reasons, the teachings of other surgeons, and gradually also my personal experience have been responsible for this change. Although we actually ignore the real cause or causes of peptic ulcer, a fact this which, as in other instances, explains and authorizes the plurality of surgical methods,

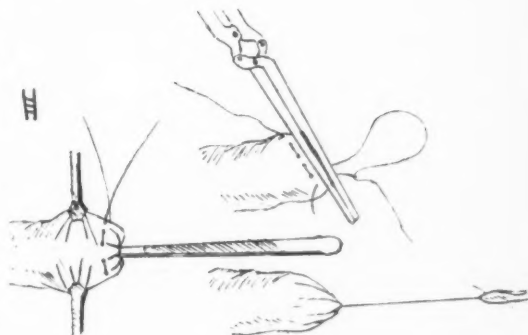
# SYSTEMATIC TREATMENT OF DUODENAL ULCER



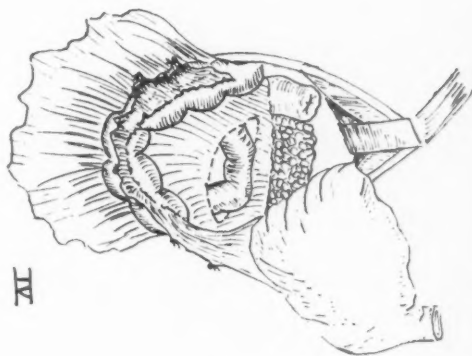
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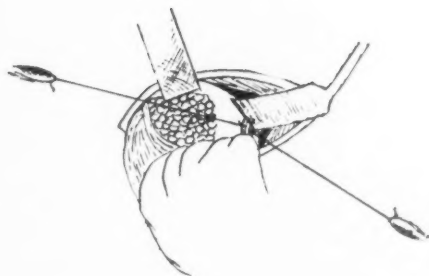


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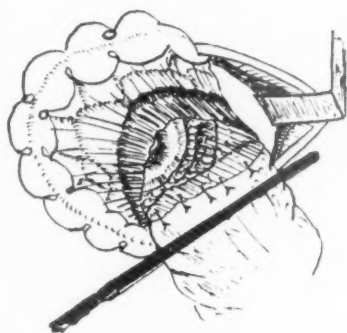


IV

FIG. 1.—(I and II.) Sketch showing écraseur applied distally to the ulcer zone on the mobilized duodenum. (IV.) Duodenal stump closed; stomach pushed to the left; jejunum appears through a slit in the mesocolon.



V



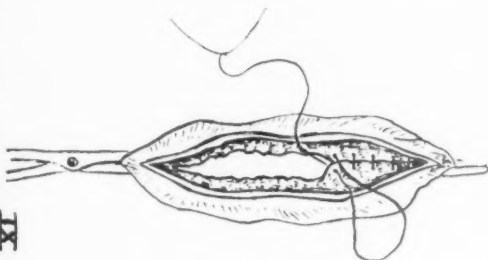
VI



VII



VIII



IX

FIG. 3.—(V.) Left gastric vessels are tied. (VI.) Posterior margin of the mesocolon slit has been sutured to posterior wall of stomach, behind jejunum. (VII.) Hemostasis of the submucosa vessels has been done and the gastroduodenal stump removed. (IX.) Narrowing the lumen of the gastric section.

still the majority of surgeons seem to favor resection for gastric ulcer; while opinions as to the best treatment of duodenal ulcer differ greatly.

We go for instance from the following statement of Sir Cuthbert Wallace:

I have never been well satisfied with the operation of G.E. for either duodenal or gastric ulcer, for I believe that there is only one thing that G.E. can cure, and that is pyloric obstruction.

To this of Deaver and Burden:

We cannot see the wisdom of partial gastrectomy for duodenal ulcer.

I have asked myself on several occasions which was the real motive that prompted many surgeons to adopt radical methods of treatment for gastric ulcer, and conservative methods for duodenal ulcer, since in both cases etiology is probably the same, and similar are the evolution and the pre-post-operative complications (apart neoplastic transformation).

And have come to the following conclusion, which I expressed in a paper read before the Accademia Lancisiana of Rome, December, 1932:

The real cause of the dislike shown by many surgeons for resection in cases of duodenal ulcer is to be found in the operative mortality, which may be very high, and which is directly proportional with the technical difficulties, often found in sufficiently mobilizing the diseased duodenum.

I was glad to read the same opinion expressed by Leriche in an article, which appeared in the *Presse Médicale* of last year:

If all surgeons could reduce their operative mortality after resection for duodenal ulcer to figures not too different from the mortality following G.E., I believe that resection for duodenal ulcer would gather the same consensus that resection for gastric ulcer has found; because, if there is no doubt that ample resection for ulcer of duodenum is a far more difficult operation than G.E., good results, both recent and remote, are of a better and more resisting quality after resection than after G.E. Is it possible to adopt resection as a systematic treatment for duodenal ulcer, without having a prohibitive post-operative mortality?

I will not mention figures just yet, but it appears to me that this possibility has been realized, in a more or less integral way, by several European surgeons.

Such a realization is certainly dependent on the personal experience of the surgeon, as regards the technic of the operation, the preparation of the patient and the post-operative treatment. Personal statistics, also, if they are not very large, are, I think, useful in giving an idea as near truth as possible of the value of a certain method, provided this has been applied to all or nearly all the cases operated on during a certain amount of time, and sufficient details are furnished.

For this reason I will deal specifically only with the cases of resection for ulcer of the duodenum, personally operated, from January, 1932, to February, 1934; they amount to 76; and represent the 9/10 of all the operations done for non-perforated duodenal ulcer during the said period.

When necessary references will be made, also, to other cases operated by me or my assistants, both in the hospitals of Venice and Rome.



# SYSTEMATIC TREATMENT OF DUODENAL ULCER

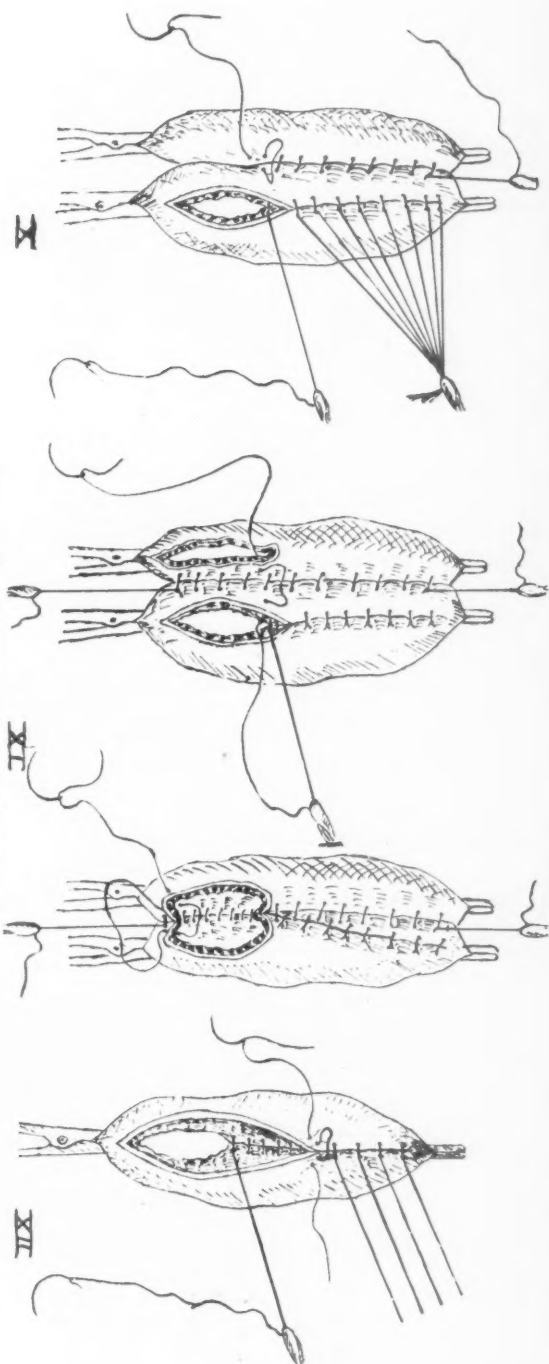


Fig. 5.—(X) Jejunum being anchored to stomach.  
Fig. 6.—(XI and XII) Different steps in gastrojejunostomy (partialis inferior).

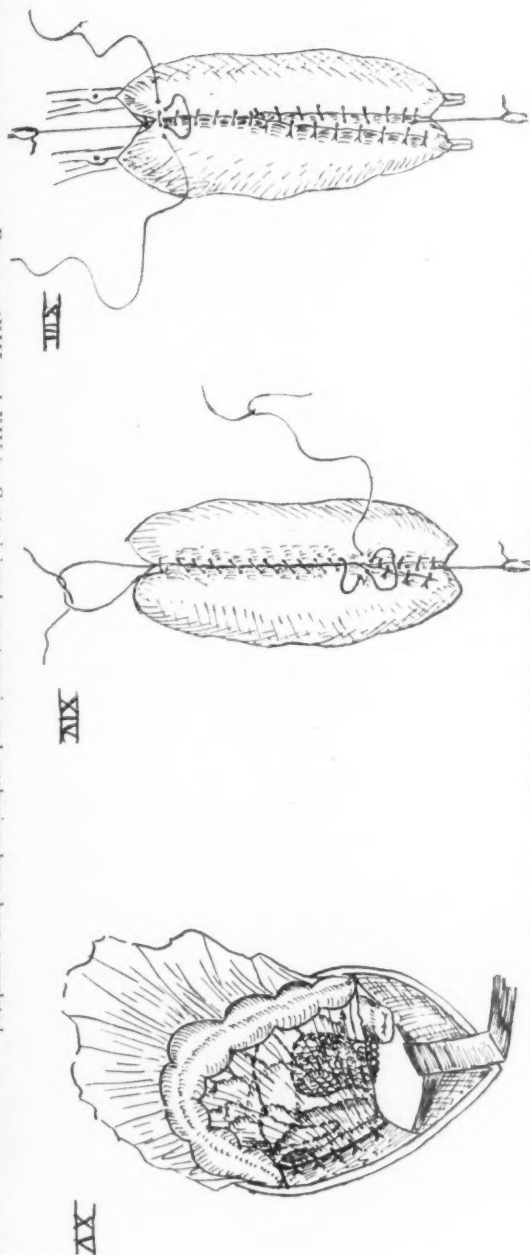


Fig. 7.—(XIII and XIV) Gastrojejunal anastomosis and anchoring have been completed.  
Fig. 8.—(XV) The anterior margin of the mesocolon silt has been sutured to anterior wall of stomach, so that all the anastomosis is under the mesocolon. The afferent loop of the jejunum is very short and is fixed to the small curvature.

*Sex and Age.*—Most of the patients were men (only seven women). Their age ranges between eighteen and seventy-four; but patients from twenty-one to forty years represent the majority (52 of the 75 cases).

*Diagnosis.*—Clinical examination helped us very little in making a diagnosis, except in cases of obstruction, or for judging of the general conditions of the patients. Local epigastric tenderness was distinctly elicited in only a few cases. On the contrary the history given by the patient generally points to a probable diagnosis of gastric or duodenal ulcer; not to a differential diagnosis, since in both cases anamnesis may be very similar, as regards the time of occurrence of the pain, its subsidence; the periodical arrangement, *etc.* Occasionally the same history may be given by patients having only a gastritis or other extragastric affections.

In the great majority of cases a history of gastric disturbances, generally periodical, and extending over many years, was given. Many of the patients had had some kind of medical treatment, and now a few of them were coming from medical wards in search of surgical help, because their ailments had grown gradually worse.

About 10 per cent. of the patients gave a history and showed signs of more or less pronounced anæmia, which was confirmed by the blood count; and in about 20 per cent. a pyloro-duodenal obstruction of different degree could be diagnosed.

*Fractional Tests.*—As a routine a fractional test of gastric secretion, after ingestion of a 5 per cent. peptone solution, was made in the majority of patients; but we did not press it on patients who objected to it. In most cases the figures of total acidity and of the free hydrochloric acid were notably above normal. The tracings of the free hydrochloric acid approached those of the total acidity; and were prolonged.

The diagnostic value of these fractional tests is only relative, since similar tracings have been occasionally found in cases of gastritis without ulcer and also in extragastric affections. But they are nearly a constant feature in duodenal ulcer, while in gastric ulcer we have often found low figures of total acidity and free hydrochloric acid. As will be mentioned later they show a definite modification after resection.

Blood (chemical test) was always present and often the gastric juice extracted contained biliary pigments.

*X-ray Examination.*—All cases, except two, were röntgenologically examined before operation, and, except in three cases, indirect and direct signs of duodenal ulcer were demonstrated. The majority of our patients were skilfully examined by the radiologist of the hospital, Doctor Milani; and his answers have always been so positive that we are loathe to operate any patient, if a duodenal niche, or at least a constant deformation of the duodenal cap has not been shown.

With regard to a comparison between X-rays and anatomical findings, these were bound to be more precise; cases, that had the same or about the

# SYSTEMATIC TREATMENT OF DUODENAL ULCER

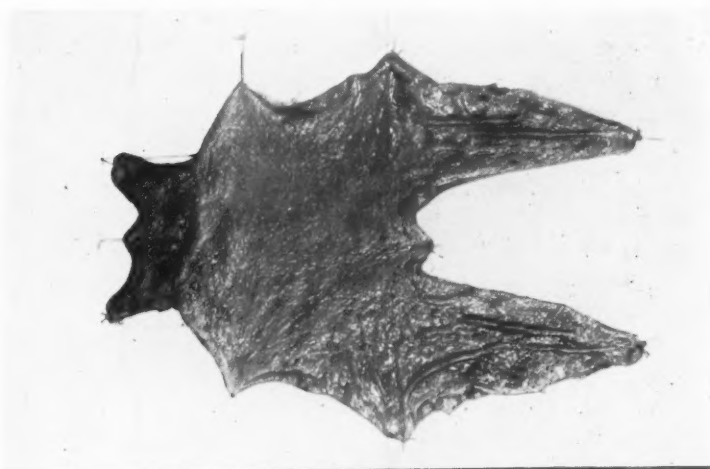


FIG. 9.—(Case I.XXII.) Two superficial ulcers on opposite walls; gastritis (12.25 centimetres).



FIG. 10.—(Case XLIII.) Two duodenal ulcers (anterior callous; posterior more superficial); gastritis.



FIG. 11.—(Case XXXII.) Two duodenal ulcers on the opposite wall; anterior with more retraction around.

same radiological picture, showed often a great variety both in number and anatomical conditions of the ulcers, and in extraduodenal lesions.

*Preparation of Patients to Operation.*—No special preparation is made, except in cases of pronounced anæmia or duodenal obstruction. Anæmic patients are given a whole blood transfusion two days or the day before operation, using Jubet's syringe of five cubic centimeters. In cases of obstruction the stomach is washed for a few days and just before operation; saline hypodermoclysis or phleboclysis is given.

*Anæsthesia.*—In the majority of cases spinal anæsthesia with novocaine-adrenalin has been used. These patients were given one hour and a half and half an hour before operation a hypodermic of ephedrin plus one ctg. of morphia. Though no special incidents have followed this kind of anæsthesia, I still have not been very satisfied with it, especially in cases of nervous patients. Lately we have used in a few cases avertin as a basal narcotic; but more and more often regional and local anæsthesia.

When the patients are given one hour and a half before operation a hypodermic of three mm. gr. of scopolamin and one ctg. of morphia; and the same dose is repeated an hour after, the operation can be comfortably carried out in local anæsthesia. In order to prevent pain during tractions on the stomach and duodenum,  $\frac{1}{2}$  per cent. novocaine solution is injected along the lesser curvature of the stomach and along the external border of the duodenum.

*Operative Technic.*—A right paramedian laparotomy between the xiphoid and the umbilicus, or a little farther down, is used. The opening of the sheet of the right rectus allows a good exposure of the subhepatic region.

The following sketches illustrate some steps of the operation; but one of the principal moments—the mobilization of the duodenum—is not shown.

This mobilization, which must be carried beyond the diseased area (Fig. 1), has been fairly easy in about half of the cases; but in the other half it has been difficult and sometimes very difficult, on account of the cicatricial adhesions between duodenum, pancreas and extrahepatic biliary ways.

I generally begin by cutting through the omentum majus near the great curvature, so as to expose the posterior wall of the stomach, going from left to right, till the beginning of the duodenum.

The difficult part begins, when, in cases of ulcer of the posterior wall of the duodenum, especially if penetrating into the pancreas, an extensive mobilization of the duodenum from pancreas has to be made.

This has been accomplished by pulling (with Allis forceps) on the duodenum on one side, and the head of pancreas on the other, so as to stretch the small vessels, which run between the two structures, and cutting them, where they leave the duodenum.

Acting in this fashion it is generally possible to penetrate in a decolable space between the posterior wall of the duodenum and the pancreas, distally to the ulcer, and then to proceed in a posterior and cranial direction, keeping always in close contact with the duodenal wall. If the ulcer is penetrating it opens during this time.

# SYSTEMATIC TREATMENT OF DUODENAL ULCER

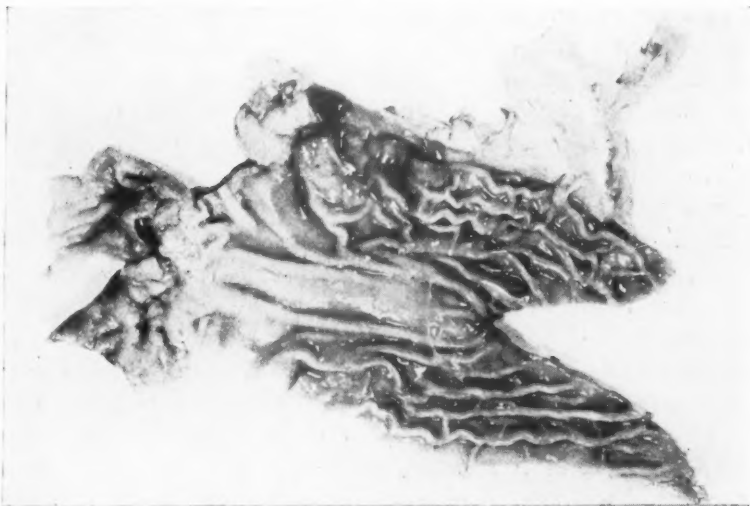


Fig. 12.—(Case XLVI.) Two duodenal ulcers on opposite walls; anterior ulcer deeper.



Fig. 13.—(Case LI.) Duodenal stenosis with multiple ulcers; one of them penetrating in pancreas.

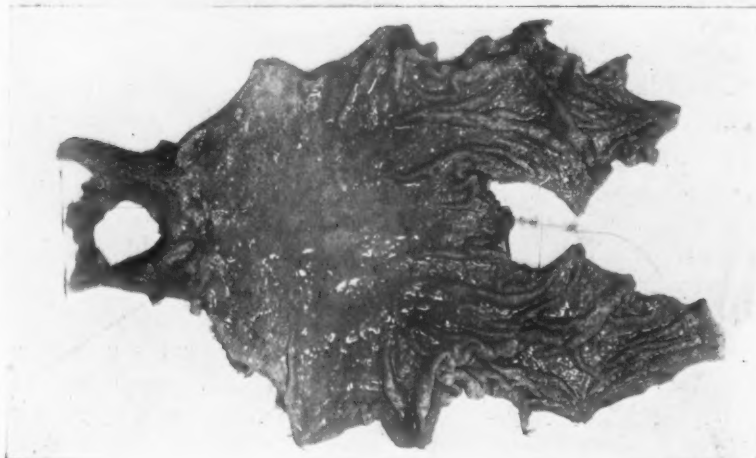


Fig. 14.—(Case LXVIII.) Large ulcer, which penetrated in omentum gastro hepaticum; duodenal stenosis; gastritis (18.31 centimetres.)



The mobilization of the anterior and external wall from the biliary ducts is generally easier, but in cases of extensive and strong adhesions it has required the previous isolation of the common duct in order not to cut into it. Also at this stage of duodenal mobilization, and during the freeing of the superior margin, it is an important rule to keep in close contact with the duodenal wall.

In nearly all the 75 cases here reported the mobilization of the duodenum was extensive enough to allow the application of a Payr's *écraseur* distally to the ulcer bearing area, or a direct incision of the duodenum. This is cut just level with the *écraseur*; a running suture of 00 catgut is applied and (after removing the *écraseur*) tied (Fig. 2, III). The stump is then infolded, either with a purse-string suture or with interrupted stitches. (Fig. 2, III.)

The infolding is a simple matter when the duodenal walls are supple (and they are if the section has been made distally to the ulcerous area) and the mobilization sufficient. Otherwise another strip of duodenum must be removed and the mobilization completed: this has been done in a few of our cases. The pancreatic capsule and strips of omentum are sutured over the infolded stump so as to cover any raw area of pancreas. The distal part of the stomach together with the ulcer bearing area of the duodenum are now turned to the left (Fig. 2, IV), while the omentum majus is cut further on to the necessary extent towards the fundus.

In order to expose the left gastric vessels an assistant retracts the left lobe of the liver, and pushes down on the pancreas, while another stretches the stomach to the left. (Fig. 3, V.)

The vein is more easily exposed; the artery lies to the left and behind, and it has to be freed from cellular strands of the small omentum. The artery and the vein have in the majority of cases been clamped separately. A good exposure of these vessels is sometimes hindered by the presence of hyperplastic lymphatic nodes. The gastric attachments of the small omentum have still to be tied and cut; and the small curvature freed over a good stretch, so as to be able to have the stomach well mobilized and the gastrostomy applied over a part absolutely free of omental tissue. At this moment the first loop of jejunum is found (this can be done also at the beginning of the operation) and passed through a hole made in the practically avascular area of the mesocolon, which lies behind the arch of the *arteria colica media*. Generally this area is large enough to be able to hold comfortably the gastric stump: only in a few cases it was a little narrow, and made some of the later stages of the operation a little more difficult; in one case it was very small, and an antecolic anastomosis according to Braun was made. The posterior margin of the slit made in the mesocolon is sutured with three or four interrupted stitches to the posterior wall of the stomach behind the gastrostomy. (Fig. 3, VI.)

The sero-muscular coats of the stomach are then cut at 2 to 3 cm. distally to the gastrostomy, first on the posterior, then on the anterior aspect; the vessels of the gastric submucosa are separately tied; the mucosa is opened and the gastroduodenal stump removed. (Fig. 4, VII, VIII.)

## SYSTEMATIC TREATMENT OF DUODENAL ULCER

The gastric stoma is shortened by suturing the margins of the cranial part of the section (Fig. 4, IX.); and then the operation is completed by making a gastrojejunostomy, and suturing on the anterior wall of the stomach the anterior margin of the mesocolon slit. (Fig. 8, XV.) A very short jejunal loop is used; the jejunum is sutured to the whole extent of the gastric section (afferent branch of the loop on the small curvature) but only a partial inferior anastomosis is made. (Fig. 5, X; Figs. 6, 7, 8.)

In cases in which the mobilization of the duodenum has been difficult I have drained the right subhepatic space with a rubber tube through a slit in the right rectus. The average time taken for the operation has been one and a half hours. The pieces of stomach resected are measured along the small and great curvature: the average extent of the resection has been 15.26 cm.; but, in cases of duodenal obstruction with gastrectasia, larger resections have been made (from 28.30 to 40.42 cm.).

*Post-operative Treatment.*—Patients are kept in bed in a semi-sitting position; a glucosed proctoclysis is given for two days; the mouth is often washed; patients are allowed to take sips of lemonade or diluted café on the second day. Saline (sometimes hypertonic) fleboclysis are given in cases of previous duodenal obstruction. In a few cases a blood transfusion was done.

The stomach is washed a few hours after the operation; and then twice a day until only biliary fluid is extracted and every stagnation has disappeared. Generally only the first or the two first extractions bring up a bloody mixture, which sometimes has a foul smell. The systematic post-operative washing of the stomach, besides relieving any tension on the sutures, seems to agree with the patients; it certainly does away with stagnation, which in different degrees is always present during the first few days; eliminates toxic materials; relieves thirst up to a certain point. Patients have not shown signs of real post-operative shock, and the post-operative course has been normal in the great majority of cases.

But, before giving the necessary details on post-operative course and results, I wish to make a few comments on some points already mentioned in the preceding paragraphs; and speak of the pathology of our cases.

*Comments on Anaesthesia and on Some Operative Steps.*—Concerning anaesthetics I have tried several of them. While there is no doubt that general anaesthesia is most comfortable both to the patient and the surgeon, I would not recommend it, except perhaps in very nervous patients, considering the length of the operation.

I will say more than this: in all the patients but one, that died following operation, general anaesthesia had been done during part of the operation, and I have the impression (though I cannot prove it) that the complications which brought some of the patients to death, had something to do with this form of anaesthesia.

Spinal anaesthesia was used in most cases with variable results. Sometimes it was remarkably good; more often it could not be called complete; tractions

on the stomach were painful and in many cases it was necessary, in order to close the parietal wound, to use local or general anaesthesia.

Lately we have tried in several cases local and regional (along the costal borders) anaesthesia, together with novocaine infiltration of the small omentum. When the patients had been prepared with injections of morphia-scopolamin (better still with dilaudid-scopolamin of the firm Knoll) this form of anaesthesia has proved satisfactory. In previous publications on gastric resection I have laid special stress on the necessity of insuring a complete haemostasis by separately tying the vessels that run in the gastric submucosa. This step requires only a few minutes and makes the patient safe and the surgeon comfortable, since post-operative bleeding from this source, which no so-called haemostatic suture is sure to prevent, will certainly not occur.

I think that not a few cases of post-operative shock are due to the bleeding of the vessels of the gastric submucosa, and some cases of post-operative toxæmia must be referred to the absorption of products of decomposition of the blood collected in the small intestine.

The separate tying of the submucosa vessels facilitates also the inner sutures, inasmuch as the mucosa need not be sutured and the infolding is easier and more complete.

I would suggest that in cases in which the vessels of the jejunal submucosa are particularly developed they too should be tied separately. As regards the extension of the resection I believe that, if one decides to treat duodenal ulcer with resection, this should be extensive. And, as the expression "extensive resection" appears to have a very different meaning according to different surgeons, we have deemed wise to give the measures and to photograph the resected specimens. Some of the photographs are here reproduced and the measures are given in the "résumé of cases."

An extensive resection should go from the ulcer bearing area (inclusive) to at least all that part of the stomach (antrum), whence the stimuli for the secretion of the fundus glands appear to start, and where inflammatory lesions are most frequent.

In order to accomplish this a large mobilization of the upper part of duodenum has been done; and we have been fortunate enough to be able in all cases of this series to cut the duodenum distally to the ulcer zone. Not once were we forced to perform a *Resektion zur Ausschaltung*. On the other side, in order to be sure to cut the stomach beyond the antrum, we tied the left gastric vessels well before they reach the small curve and then free this from all attachments for several inches towards cardias and pylorus, so as to be able to exteriorize at least two-thirds of the whole stomach.

Only in a few cases in which many adhesions were found around the stomach, or where many hyperplastic lymph-nodes were collected along the small curve, the mobilization was a little difficult, and in one case a slit was cut through the upper part of the small curve into the stomach. In those cases in which a good stretch of muscular coat appears uncovered along the peeled

## SYSTEMATIC TREATMENT OF DUODENAL ULCER

small curve, we have it covered by uniting with a few stitches the serosa of the anterior to that of the posterior wall.

I have not used the whole extent of the gastric section for the anastomosis in order to prevent a too quick emptying of the stomach (gastrojejunostomia partialis inferior). But the jejunum was anchored from small to great curvature, so as to prevent any kinking and to have in the end a vertical anastomosis from proximal (upper) to distal branch. (After resection for gastric ulcer I generally make a gastroduodenostomy.—Billroth I.)

This kind of anastomosis, at the X-rays control, seems to work in a satisfactory way, since in most cases the gastric content empties itself rhythmically, and the proximal branch of the jejunum and the duodenum don't get filled with the barium meal.

The draining of the right subhepatic space, already mentioned, proved really useful in two cases, in which, for several days, a whitish fluid (of pancreatic origin) drained through the rubber tube, and in one case, in which, besides the gastric resection, a cholecystectomy had been performed.

Other operations besides gastric resection were done in four cases: two cholecystectomies for gall-stones; one appendectomy (appendix adherent to gall-bladder); one resection of accessory pancreas of the jejunum (the resulting opening in the jejunum was used for the anastomosis).

*Pathology.*—In 40 cases there existed only one ulcer (26 of the anterior and 14 of the posterior wall); in 35 cases more than one ulcer was found, generally two, one in front of the other, or, more rarely, on the same side. In four of these 35 cases there was an ulcer of the small curvature of the stomach besides the duodenal ulcers.

In only one case was the ulcer situated at the level of the pyloric sphincter; all the others were frankly duodenal, their distance from the pyloric ring varying from a few mm. to two and three and one-half cm. Sometimes, especially in cases of duodenal stenosis, a ring of small ulcers was found near a callous, often penetrating ulcer; or a deep ulcerated fissure, extending to one half or more of the duodenal circumference; or two callous ulcers, connected by a fissure (hour-glass ulcer). The appearance of the ulcers varied a good deal; some of them were quite small and superficial, others had infiltrated and elevated margins, and penetrated as far as the serosa; in some the borders were ragged; while other ulcers were penetrating into the small omentum, or the liver, or the coats of the gall-bladder, or, more often, into the pancreas. To these last ones belong the majority of those really enormous ulcers, which are not rare, and of which examples are given in the photographs. In 29 cases there existed a duodenal stenosis of varying degree. The obstruction, which was not always clinically evident, was mostly due to the infiltration and retraction of the duodenal coats around the ulcers; but it was certainly aggravated by the periduodenal adhesions and inflammatory reactions.

In every case of duodenal obstruction one or more ulcers were found. Though histological examination of the operative specimens has not yet been done, still, in the majority of cases, the duodenum, and often the stomach,

showed to the naked eye evident lesions, which are generally defined as duodenitis and gastritis.

The duodenal coats around the ulcer were more or less extensively thickened; the mucosa appeared in the majority of cases of a deep red; was sometimes cedematous, and showed erosions; it was retracted around callous ulcers.

The gastric mucosa had often a purple color; in some cases there were hæmorrhagic foci; in others the mucosa of the antrum was covered with small umbilicated eminences; and in two cases several of these papules were largely ulcerated. In other specimens the mucosa appeared cedematous, or had a variegated appearance.

Gastric dilatation, sometimes enormous, and thickening of the gastric coats accompanied duodenal obstruction. Extraduodenal and extragastric findings were very interesting; unfortunately they do not appear on the resected specimens.

In nearly all cases hyperplastic lymph-nodes, varying in number and size, were found in both omenta. They were especially abundant along the medial margin of the duodenum and the small curvature of the stomach. These same gray-pink, friable glands were found also in cases of gastroduodenitis without ulcer.

Perigastric, but especially periduodenal adhesions were a constant feature. While perigastric adhesions in most cases were not very developed, those around the duodenum showed a great variability; from thin and easily detachable membranes to strands of connective tissue, which united the duodenum to the biliary ways and the liver, the colon; to the transformation of the right omentum in a thick layer of tissue, which rendered duodenal mobilization difficult.

In cases in which the ulcer was penetrating in the small omentum, or liver, or gall-bladder coats lardaceous connections were met; in dissecting them the penetrating ulcer was usually opened.

The most frequent form of ulcer-penetration was into the pancreas. More or less extensive thickening of the head of pancreas was often met in cases also of non-penetrating ulcer of the posterior wall; but it was a constant and definite feature of penetrating ulcers.

This penetration and the extensive adhesions between duodenum and pancreas represent one of the most important difficulties to a complete duodenal mobilization; we have already mentioned the steps that were taken to overcome them.

By far the most advanced periduodenal lesions were found in cases of chronic duodenal obstruction; the upper section of the duodenum appears to be a part of an inflammatory swelling, in which duodenum, biliary ways, head of pancreas, right section of small omentum, are matted together by strong adhesions. The duodenum itself looks as if it was amputated; and its mobilization from the other structures may prove very difficult. Para-ulcerous diverticles (lateral or on the pyloric side of the ulcer) were often found.

*Post-operative Results.*—The majority of patients did well after operation.



## SYSTEMATIC TREATMENT OF DUODENAL ULCER

We have not observed a single case of serious immediate post-operative shock. Pulmonary complications were not frequent and generally mild; a contrast with what I had observed in the patients operated by me in the old hospital of Venice.

In two cases a phlebitis of the left leg developed; in one a parotitis. In two cases a transitory discharge of pancreatic juice took place through the drainage tube; in another, in which, besides the resection, a cholecystectomy had been done, bile drained for a few days. In one case a subhepatic abscess formed and was drained. Partial infections of the subcutaneous tissue were frequent. The average permanence of the patients in hospital after operation has been three weeks.



FIG. 15.—Male, thirty-three. (Case not included in this series.) Resection for duodenal ulcer perforated. Ulcer is comma-like; gastritis.



FIG. 16.—(Case not included in this series). Perforated duodenal ulcer.

A fractional control test of gastric secretion was done in the majority of cases; it nearly always showed a thorough change in the tracings, with a drop in the total acidity and in the free hydrochloric acid. Examples of fractional test before and after operations are here given; (Figs. 17 to 22); in one of them, tracings taken nine months after, were very similar to those taken immediately after operation. X-rays controls, taken two weeks after operation, and in several cases after more than one year, showed that the stomach emptied itself rhythmically, and that only the efferent branch of the jejunum was filled with the barium meal. Only in a few cases tumultuous emptying of the stom-

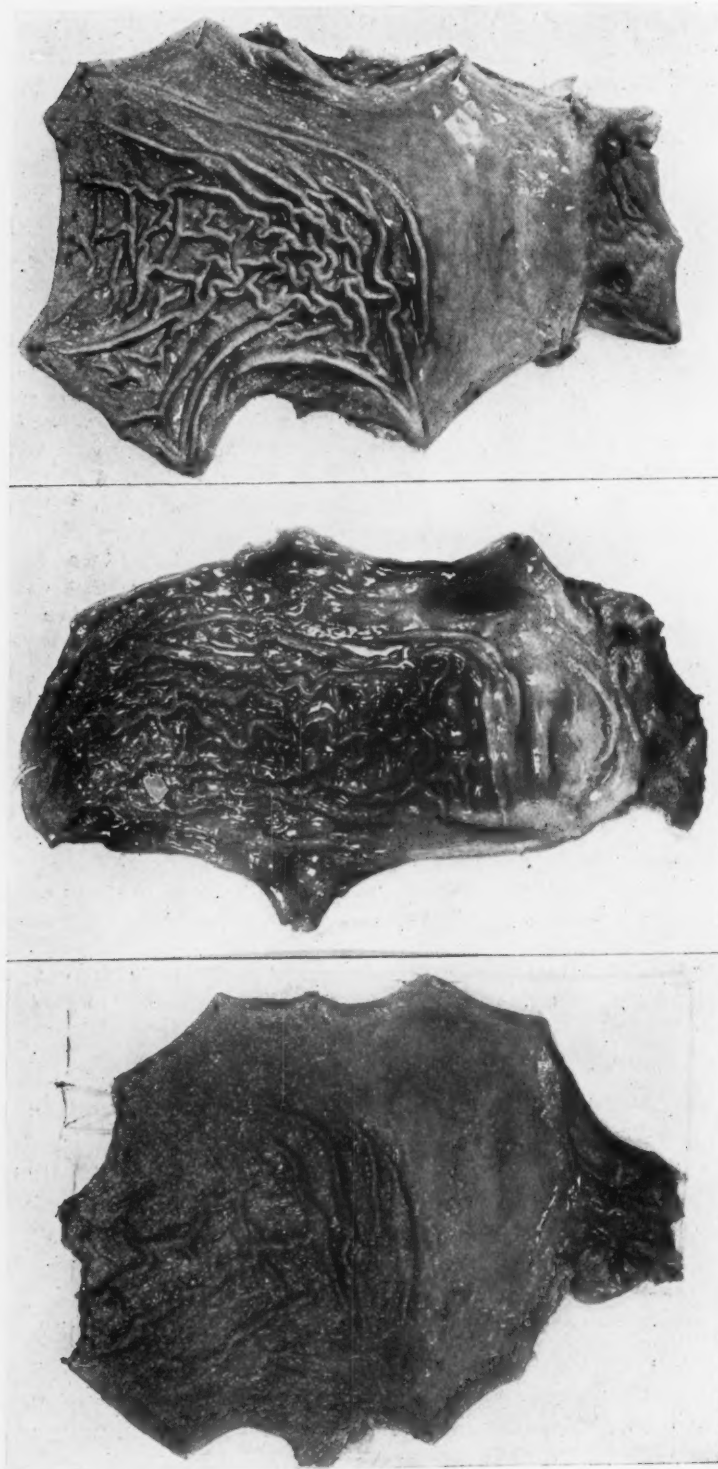


FIG. 17.—(CASE LVI.) Ulcer (callous) anterior wall with much retraction and stenosis (17.30 centimetres).  
 FIG. 18.—(CASE LIV.) Two duodenal ulcers; cal-  
 lous ulcer anterior wall; superficial on posterior.  
 FIG. 19.—(CASE XLII.) Two duodenal ulcers  
 fairly superficial.

## SYSTEMATIC TREATMENT OF DUODENAL ULCER

ach was observed, and sometimes a partial injection of the afferent branch.

In one case (No. 70, 1933) a stasis in the afferent branch was detected; the patient was complaining of pains after ingestion of food.

*Hospital Mortality.*—Seven of the 75 patients died in the hospital (9.4 per cent.).

CASE I.—(No. 156, 1932.) Resection for duodenal ulcer penetrating in pancreas; resection of transverse colon on account of accidental wound of arteria colica media; sutured colon appears to press over anastomosis. Stormy post-operative course; symptoms of gastrocolic fistula develop in a short time; patient refuses operation until he is practically moribund. Operation shows jejunocolic fistula, and is limited to separation of colon from jejunum and suture of fistula's orifices. Patient died on the same day (two and half months after first operation).

CASE II.—(No. 323, 1932.) Easy resection for ulcer anterior wall. General conditions appear serious next day; high temperature and very frequent pulse. Chest examination gave signs of diminished expansion of lungs. Exploration of operative field negative. Death on third day.

CASE III.—(No. 486, 1932.) Duodenal stenosis of high degree; multiple ulcers; very ample resection (23.42 cm.). Irregular post-operative course; fair general condition alternating with adynamia; foul gastric retention. Patient died on sixth post-operative day.

CASE IV.—(No. 412, 1933.) Easy resection for ulcer anterior wall; cholecystectomy for gall-stones (very fat woman sixty-four years old). Next day serious general conditions; very frequent pulse with low temperature; exploration of operative field shows signs of fat degeneration of liver. Death on fourth day.

CASE V.—(No. 419, 1933.) Easy resection for ulcer anterior wall. Next day very frequent pulse and high temperature (40 degrees centigr.). Death on second day.

CASE VI.—(No. 557, 1933.) Easy resection for superficial ulcer posterior wall. Symptoms of bronchopneumonia. Death on third day.

CASE VII.—(No. 728, 1933.) Difficult resection for ulcer of posterior wall penetrating in pancreas; tear in small curvature of stomach during its mobilization. Irregular post-operative course, with fever. Death on eighth post-operative day.

Unfortunately no post-mortem was obtained, so that the cause of death was ascertained only in the case in which a jejunocolic fistula was found at the second operation.

In two other cases an exploration of the operative field was deemed necessary: it showed only a fatty degeneration of liver in the case, which had been operated also for cholecystectomy.

In three cases (Nos. 392, 419, 557) in which resection had been very easy and in which death occurred during second and third day, it is very likely that a pulmonary complication was the cause of death.

In two other cases (Nos. 486, 728) resection had been particularly difficult and a local infection as the cause of death cannot be excluded. In all these cases, except in the first, ether had been used as an anæsthetic during part of the operation.

## CONCLUSIONS

Since my personal experience of duodenogastric resection for duodenal ulcer may be said to start really only from 1929, and since I have no actual news of the majority of patients operated in Venice up to the end of 1931, I cannot speak of late results, except in the sense that I have seen now and again



FIG. 22.—(Case XXXV.) Penetrating ulcer posterior wall and superficial ulcer near; existing stenosis does not appear in distended specimen.



FIG. 21.—(Case LXVI.) Large penetrating ulcer anterior wall; small ulcer opposite; existing stenosis not apparent on distended specimen (21.31 centimetres).

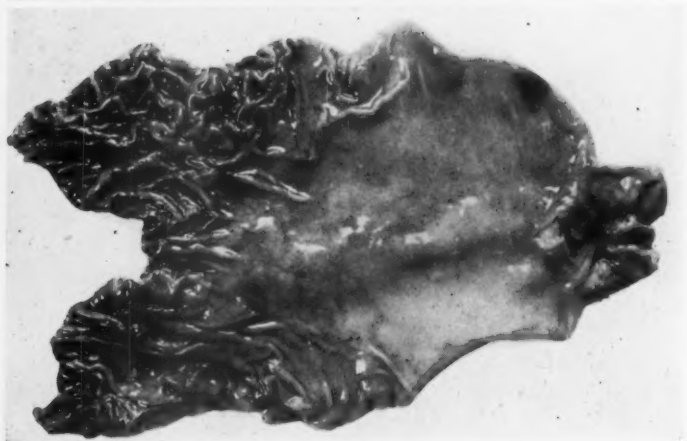


FIG. 20.—(Case I.II.) Two ulcers anterior wall duodenum; duodenal stenosis, small diverticle proximal to ulcers.

## SYSTEMATIC TREATMENT OF DUODENAL ULCER

patients which had been operated from a few months to more than two years.

Most of these patients belong to the working class and had not followed any dietetic rule after operation. They looked and said they felt very well.

My assistant, Doctor Ugelli, has already done blood counts on several of them, and has found that the number of red corpuscles is normal and sometimes above normal, while the hæmoglobin in some cases has been found a little below normal.

As a matter of fact this paper has been written with the principal idea of describing the operative technic and the pathological findings, and of analyzing the immediate results of systemic resection in the treatment of duodenal ulcer. Systemic resection meaning in this case that out of a total of 81 non-perforated duodenal ulcers personally operated during twenty-six months 76 were treated with resection; four with infrapapillary gastroduodenostomy; one with G.E.

The hospital mortality of 9.2 per cent. in this series of 76 resections gives an idea of the operative risk of systemic resection done by one man. Mortality after resection for gastric ulcer (18 cases) during the same period of time was 5.5 per cent.

A comparison with the mortality following conservative operations done by me during the same time is not possible on account of the small number of operations (5 cases); and I cannot quote as a term of comparison the more than 13 per cent mortality in a series of 44 G.E. done in Venice from 1928 to 1931, since these operations were performed under very different conditions (during the same time the mortality after resection was more than 20 per cent.).

This shows that a progress has certainly been made, due partly to different organization, partly to increased personal experience; and at the same time it points to the fact that one must be very careful in making comparisons and in drawing conclusions.

I quite realize that gastric resection for duodenal ulcer, being a far more complex procedure than conservative methods, may prove more dangerous than these. But a great deal depends on the experience of the surgeon and on his not being too rigid.

The fact that we have applied the resection treatment, during the said period of time, to practically all cases of duodenal ulcers, and that still the mortality has not proved absolutely prohibitive (and we have followed Pool's advice that every patient who died in hospital after resection, whatever the cause, was "put down as dead") must be taken into consideration. And the more so since the argument of operative mortality, though of fundamental importance, is not the only one that weighs on the surgeon's judgment; otherwise there would be no reason for radical operations.

A well-planned and correctly performed duodenogastric resection for duodenal ulcer does away not only with the ulcer, which is only a part of the pathology, but removes that part of peri-ulcerous duodenum, which is always



diseased; the gastric antrum, which, in the majority of cases, is not a "healthy part of stomach," but shows gastritic lesions (sometimes very severe) and whose function seems to have become abnormal. It does something more: Duodenal ulcer in many cases, at a certain time of its evolution, ceases to be a purely duodenal or duodenogastric affection, since the structures around it are affected not only by the process of ulcer penetration, but also by inflammatory and degenerative lesions, and ultimately by the formation of scar tissue, which may seriously interfere with their function.

The mobilization of the duodenum, which is one of the most important steps of resection, results also in the freeing of the structures around it. No wonder that a cure after a "well-planned resection" should prove more complete and more lasting.

RÉSUMÉ OF CASES  
(1932)

CASE I.—(No. 11.) Male, twenty-three. Spinal anæsthesia and ether. Lardaceous thickening anterior wall duodenum; adhesions to biliary tract; hyperplastic glands in omenta. Resection (10.21 cm.); subhepatic drain. *Diagnosis*.—Penetrating ulcer anterior wall duodenum, 2 cm. from pylorus.

CASE II.—(No. 36.) Male, twenty-seven. Spinal novocaine infiltration of small omentum. Hard thickening posterior part pylorus; resection (10.21 cm.). *Diagnosis*.—Callous ulcer posterior part pyloric ring.

CASE III.—(No. 45.) Male, thirty-six. Spinal. Periduodenal adhesions; head of pancreas hard; ulcer penetrating in pancreas opened during mobilization of duodenum; resection (11.32 cm.). *Diagnosis*.—Ulcer posterior wall duodenum penetrating in pancreas.

CASE IV.—(No. 89.) Female, thirty-two. Spinal; scar deforming anterior wall of duodenum; resection (16.30 cm.). Superficial ulcer anterior wall at 2 cm. from pylorus; para-ulcerous diverticula; gastritis. *Diagnosis*.—Ulcer anterior part duodenum; gastritis.

CASE V.—(No. 99.) Male, forty-nine. Spinal; periduodenitis fibrosa; duodenal stenosis; resection (20.35 cm.). *Diagnosis*.—Two duodenal ulcers, subpyloric stenosis; gastritis.

CASE VI.—(No. 126.) Male, forty-seven. Spinal; scar anterior wall duodenum; adhesions with gall-bladder; several lymph-nodes in omenta; resection (12.24 cm.); drain in subhepatic region. *Diagnosis*.—Ulcer anterior wall duodenum; duodenitis.

CASE VII.—(No. 156.) Male, nineteen. Spinal; periduodenitis fibrosa; difficult mobilization of duodenum; ulcer penetrating in pancreas opens; resection (16.26 cm.); arteria colica media accidentally wounded; resection of transverse colon (colon sutured seemed to press on anastomosis). *Diagnosis*.—Ulcer penetrating in pancreas. Death two and one-half months after operation following jejunum-colic fistula.

CASE VIII.—(No. 166.) Male, thirty-four. Spinal and ether; duodenum is fixed to gall-bladder and transverse colon by strong adhesions; head of pancreas hard. Mobilization of duodenum difficult; resection. *Diagnosis*.—Two duodenal ulcers near pylorus; duodenal stenosis; gastrectasia.

CASE IX.—(No. 187.) Male, twenty-five. Spinal and local; scar on anterior wall duodenum; adhesions with gall-bladder; resection (13.26 cm.). *Diagnosis*.—Two duodenal ulcers (on anterior and posterior wall) fairly superficial.

CASE X.—(No. 218.) Male, twenty-seven. Spinal and local; thickening anterior wall duodenum with œdema of serosa; hyperplastic lymph-nodes in omenta; resection (14.24 cm.); subhepatic drain. *Diagnosis*.—Two ulcers of duodenum at  $\frac{1}{2}$  cm. from pylorus; one of them has hard borders.

## SYSTEMATIC TREATMENT OF DUODENAL ULCER

CASE XI.—(No. 263.) Female, sixty-eight. Spinal; scar anterior wall duodenum; thickening on small curvature; gall-bladder containing stones; resection (Billroth I); cholecystectomy; subhepatic drain. *Diagnosis*.—Ulcer small curvature penetrating in pancreas; ulcer anterior wall duodenum; cholecystitis calculosa.

CASE XII.—(No. 271.) Male, thirty-two. Spinal and local; scar on anterior wall; pancreas in contact with posterior wall hard; perigastritis fibrosa; an ulcer on posterior wall opens during mobilization of duodenum; resection (14.30 cm.); antecolic anastomosis and enterostomy. *Diagnosis*.—Lenticular ulcer on anterior wall; penetrating ulcer on posterior wall; hypertrophic gastritis and erosions on gastric mucosa.

CASE XIII.—(No. 285.) Male, thirty-three. Spinal; scar on anterior wall duodenum; periduodenitis and perigastritis fibrosa; resection (14.26 cm.). *Diagnosis*.—Ulcer anterior wall duodenum.

CASE XIV.—(No. 323.) Male, twenty-five. Spinal and ether; scar anterior wall duodenum; glands in omenta; mobilization of duodenum easy; resection (13.27 cm.). *Diagnosis*.—Ulcer anterior wall duodenum at 2 cm. from pylorus. Abnormal post-operative course: high temperature and very frequent pulse. Transfusion without any effect. Patient died on third post-operative day.

CASE XV.—(No. 328.) Male, twenty-nine. Spinal and ether; scar anterior wall duodenum; periduodenitis and perigastritis; glands in omenta. Resection; subhepatic drain. *Diagnosis*.—Ulcer anterior wall duodenum.

CASE XVI.—(No. 358.) Male, fifty-seven. Spinal; adhesions between duodenum and gall-bladder; thickening posterior wall and pancreas; resection (14.26 cm.); subhepatic drain. *Diagnosis*.—Ulcer posterior wall duodenum penetrating in pancreas; moderate degree of duodenal stenosis.

CASE XVII.—(No. 405.) Male, seventy-four. Spinal and local; retracted scar anterior wall duodenum; thickening on small curve of stomach; glands in omenta; resection (17.30 cm.). *Diagnosis*.—Ulcer anterior wall duodenum at  $\frac{1}{2}$  cm. from pylorus; superficial ulcer on small curvature of stomach.

CASE XVIII.—(No. 486.) Male, thirty-six. Spinal and ether; gastrectasia; stenosis of high degree first part of duodenum (duodenum appears strangled) resection (23.42 cm.); subhepatic drain. *Diagnosis*.—Nearly impermeable subpyloric stricture. Patient died on sixth post-operative day; no autopsy.

CASE XIX.—(No. 506.) Male, thirty-four. Spinal; scar anterior wall duodenum; glands in omenta; resection. *Diagnosis*.—Ulcer anterior wall duodenum.

CASE XX.—(No. 618.) Male, twenty-nine. Spinal; scar anterior wall duodenum; resection. *Diagnosis*.—Ulcer anterior wall duodenum at two cm. from pylorus.

CASE XXI.—(No. 640.) Male, forty. Spinal and ether. Scar anterior wall duodenum; resection (12.26 cm.). *Diagnosis*.—Ulcer on anterior and posterior wall at a few mm. from pyloric ring.

CASE XXII.—(No. 666.) Male, forty-two. Spinal and local; scar anterior wall duodenum; perigastritis and periduodenitis of moderate degree; few glands in omenta; resection. *Diagnosis*.—Large ulcer anterior wall duodenum.

CASE XXIII.—(No. 667.) Male, twenty-five. Spinal and ether; first part duodenum stenosed and deformed; periduodenitis; resection (10.25 cm.). *Diagnosis*.—Two ulcers coalescing have formed fissure which encircles most part of duodenum, producing a stricture.

CASE XXIV.—(No. 676.) Male, thirty-three. Spinal; first part duodenum is thickened and deformed; adhesions with biliary tract and liver; head of pancreas hard; perigastritis; ganglia in omenta; resection (14.28 cm.). *Diagnosis*.—Large ulcer penetrating towards pancreas; moderate duodenal stenosis.

CASE XXV.—(No. 715.) Male, fifty-six. Spinal and ether; inflammatory mass formed by part of duodenum and head of pancreas; difficult mobilization of duodenum; resection (15.32 cm.); subhepatic appendix: appendectomy; subhepatic drain. *Diagnosis*.—Duodenal stenosis; ulcer penetrating into pancreas.

ANGELO CHIASSERINI

CASE XXVI.—(No. 719.) Male, twenty-nine. Spinal; scar on anterior wall duodenum; periduodenitis and perigastritis; glands in omenta; resection (14.31 cm.). *Diagnosis*.—Two duodenal ulcers (anterior and posterior) at one cm. from pyloric ring.

CASE XXVII.—(No. 765.) Male, twenty-three. Spinal and ether; gastrectasia; thickening posterior wall duodenum and head of pancreas; fibrous periduodenitis; resection (16.30 cm.); glands in omenta. *Diagnosis*.—Ulcer (bleeding) posterior wall penetrating in pancreas.

CASE XXVIII.—(No. 775.) Male, twenty-two. Spinal and local; scar anterior wall duodenum; thickening on small curvature; many lymph-nodes in omenta; resection (15.33 cm.). *Diagnosis*.—Two gastric ulcers (bleeding); two duodenal ulcers anterior wall; duodenal stenosis.

CASES XXIX–XXX.—Two young male patients operated on during March, 1932, in the Hospital of Venice: in both cases resection. *Diagnosis*.—In each case two duodenal ulcers (anterior and posterior wall). (1933.)

CASE XXXI.—Male, forty. (Patient operated on outside hospital.) Spinal; stricture of duodenum of high degree; gastrectasia; periduodenitis and perigastritis; glands in omenta; resection (18.35 cm.); subhepatic drain. *Diagnosis*.—Duodenal stricture with multiple duodenal ulcers.

CASE XXXII.—Female, thirty-two. (Operated outside hospital.) Spinal and local; periduodenitis; glands in omenta; scar anterior wall duodenum; resection (14.26 cm.); subhepatic drain. *Diagnosis*.—Two duodenal ulcers (anterior and posterior).

CASE XXXIII.—(No. 70.) Male, forty. Spinal and ether; scar anterior wall duodenum; head of pancreas hard; glands in omenta; resection; ulcer on posterior wall opened (16.30 cm.); subhepatic drain. *Diagnosis*.—Ulcer penetrating in pancreas; duodenitis gastritis; moderate duodenal stenosis.

CASE XXXIV.—(No. 100.) Male, forty-two. Spinal; adhesions between duodenum and gall-bladder; glands in omenta; duodenal stricture and periduodenitis; during mobilization ulcer penetrating in pancreas opened; resection (18.33 cm.); subhepatic drain. *Diagnosis*.—Duodenal stenosis with large ulcer penetrating in pancreas; diverticula near ulcer; atrophy gastric mucosa.

CASE XXXV.—(No. 150.) Male, thirty-nine. (Patient says he has been operated for gastric troubles, but no sign of operation on stomach or duodenum is found beside xyphoid-umbilical scar.) Spinal; strong adhesions between duodenum and inferior part liver; gastrectasia; difficult mobilization of duodenum during which ulcer penetrating in pancreas opened; glands in omenta; resection; subhepatic drain. *Diagnosis*.—Multiple duodenal ulcers; one penetrating in pancreas; duodenal stenosis.

CASE XXXVI.—(No. 200.) Male, thirty-six. Spinal and local; scar anterior wall duodenum; perigastritis and periduodenitis; glands in omenta; resection (16.23 cm.). *Diagnosis*.—Ulcer anterior wall duodenum at one cm. from pylorus; para-ulcerous diverticles; gastritis, duodenitis.

CASE XXXVII.—(No. 207.) Male, fifty. Spinal; surface of liver appears granular; gastrectasia; adhesions round first part of duodenum which appears deformed; glands in omenta; resection (16.32 cm.). *Diagnosis*.—Two duodenal ulcers; moderate duodenal stenosis; polypous gastritis.

CASE XXXVIII.—(No. 211.) Male, twenty-seven. Spinal; scar on anterior wall; resection. *Diagnosis*.—Ulcer anterior wall duodenum.

CASE XXXIX.—(No. 221.) Male, thirty-five. Spinal; very large stomach; omentum without fat; ganglions in omenta; (upper duodenum is a part of a whitish and edematous swelling; accessory pancreas on first loop of jejunum; resection (23.38 cm.); subhepatic drain. *Diagnosis*.—Duodenal stenosis and gastrectasia; multiple duodenal ulcers, one of which penetrates in pancreas; gastritis with umbilicated papulae; accessory pancreas in jejunal wall.

CASE XL.—(No. 235.) Male, thirty-one. Spinal and local; small stomach; deform-

## SYSTEMATIC TREATMENT OF DUODENAL ULCER

ing scar anterior wall of duodenum; moderate periduodenitis; glands in omenta; resection (13.23 cm.). *Diagnosis*.—Callous ulcer anterior wall duodenum very near pylorus; gastritis.

CASE XLI.—(No. 306.) Male, forty-three. Spinal and ether; scar on anterior wall duodenum whose right margin is thickened; strong adhesions with biliary ways; resection (15.30 cm.); subhepatic drain. *Diagnosis*.—Callous ulcer right margin of duodenum.

CASE XLII.—(No. 380.) Male, twenty-nine. Local; scar anterior wall duodenum; periduodenitis fibrosa; adhesions with liver; difficult mobilization of duodenum; resection (16.30 cm.); subhepatic drain. *Diagnosis*.—Two ulcers (anterior and posterior wall duodenum); posterior ulcer deeper at one cm. from pylorus; moderate stenosis.

CASE XLIII.—(No. 406.) Male, nineteen. Spinal and ether; anterior wall duodenum shows hyperæmic swelling; periduodenitis; resection (16.29 cm.); subhepatic drain. *Diagnosis*.—Callous ulcer anterior wall; superficial ulcer posterior wall; gastritis; moderate stenosis.

CASE XLIV.—(No. 412.) Female, sixty-four. Spinal and ether; scar anterior wall duodenum; gall-stones; gastric resection; cholecystectomy; subhepatic drain. *Diagnosis*.—Ulcer anterior wall duodenum; gall-stones. Patient died on fourth post-operative day.

CASE XLV.—(No. 419.) Male, twenty-six. Spinal and ether; thickening anterior wall duodenum; easy mobilization; resection (16.30 cm.); subhepatic drain. *Diagnosis*.—Ulcer anterior wall duodenum. Patient died on second post-operative day.

CASE XLVI.—(No. 444.) Female, eighteen. Local; periduodenal œdema; hyperæmic patch on anterior wall; head of pancreas hard; resection (16.29 cm.); subhepatic drain. *Diagnosis*.—Two duodenal ulcers (superficial on anterior wall; deep callous ulcer on posterior wall).

CASE XLVII.—(No. 452.) Male, thirty-one. Local; duodenum bound by strong adhesions to biliary tract; mobilization difficult; ulcer anterior wall penetrating opens; resection (16.28 cm.); subhepatic drain. *Diagnosis*.—Gastritis and duodenitis; large penetrating ulcer on anterior wall at three and one-half cm. from pylorus.

CASE XLVIII.—(No. 463.) Male, twenty-seven. Local; large duodenum; head of pancreas hard; ganglions in omenta; resection (15.28 cm.); subhepatic drain. *Diagnosis*.—Small superficial duodenal ulcers.

CASE XLIX.—(No. 464.) Male, forty-six. Local; scar on anterior wall duodenum, which appears stenosed; head of pancreas hard; periduodenal adhesions; gastrectasia; difficult mobilization of duodenum (ulcer of posterior wall opened); resection (23.34 cm.); subhepatic drain. *Diagnosis*.—Duodenal stenosis with multiple ulcers; one ulcer penetrating in pancreas.

CASE L.—(No. 488.) Male, twenty-seven. Local; scar anterior wall, which is thickened; glands in omenta; easy mobilization of duodenum; resection (16.30 cm.). *Diagnosis*.—Two duodenal ulcers (anterior and posterior); duodenitis; hæmorrhagic gastritis with umbilicated papulae.

CASE LI.—(No. 511.) Male, thirty-one. Local; œdema anterior face duodenum with red area; duodenum fairly mobile; resection (16.27 cm.). *Diagnosis*.—Two duodenal ulcers (anterior and posterior).

CASE LII.—(No. 551.) Male, sixty. Local; thickened area on anterior wall duodenum at two to three cm. from pylorus; duodenal stenosis; periduodenitis; resection (18.30 cm.); subhepatic drain. *Diagnosis*.—Moderate duodenal stenosis; two ulcers (anterior) at one cm. from pylorus; small diverticle.

CASE LIII.—(No. 557.) Male, twenty-one. Spinal and ether; glands in omenta; resection (16.29 cm.). *Diagnosis*.—Superficial ulcer posterior wall; gastritis. Patient died on third post-operative day.

CASE LIV.—(No. 560.) Male, thirty-five. Local; scar anterior wall duodenum; perigastritis; ganglions in omenta; easy mobilization of duodenum; resection (16.30 cm.). *Diagnosis*.—Two duodenal ulcers (callous ulcer anterior wall; posterior ulcer superficial).

CASE LV.—(No. 728.) Male, twenty-seven. Local and ether; thick perigastric

and periduodenal adhesions; head of pancreas hard; difficult mobilization of duodenum (ulcer posterior wall opened); tear on small curvature of stomach after tying left gastric artery; resection (14.26 cm.); subhepatic drain. *Diagnosis.*—Ulcer posterior wall duodenum penetrating in pancreas. Patient died on eighth post-operative day.

CASE LVI.—(No. 735.) Male, twenty-eight. Local; thickening anterior wall duodenum; periduodenitis; glands in omenta; resection (17.30 cm.); subhepatic drain. *Diagnosis.*—Callous ulcer anterior wall; duodenal stenosis.

CASE LVII.—(No. 774.) Male, thirty-six. Local; gastrectasia; scar anterior wall duodenum which appears deformed, stenosed; strong adhesions to biliary tract; glands in omenta; during duodenal mobilization ulcer penetrating in hepatoduodenal ligament opened; resection (20.40 cm.); subhepatic drain. *Diagnosis.*—Penetrating ulcer anterior wall at one and one-half cm. from pylorus; duodenal stenosis; hæmorrhagic duodenitis oedema gastric mucosa; gastrectasia.

CASE LVIII.—(No. 786.) Male, forty. Local; very large stomach; duodenal stricture; periduodenitis fibrosa; head of pancreas hard; resection not easy (22.36 cm.); subhepatic drain. *Diagnosis.*—Duodenal stenosis and gastrectasia; multiple duodenal ulcers.

CASE LIX.—(No. 805.) Male, forty-one. Local; scar on anterior wall; thickening posterior wall with hard pancreas; moderate periduodenitis; glands in omenta; mobilization not difficult; resection (20.27 cm.); subhepatic drain. *Diagnosis.*—Large callous ulcer posterior wall; purple color of gastric mucosa; duodenitis.

CASE LX.—(No. 888.) Male, thirty-three. Local; large stomach; ganglions in omenta; duodenum with circular thickening; difficult mobilization; surface of liver granular; resection (14.29 cm.); subhepatic drain. *Diagnosis.*—Moderate duodenal stenosis; two duodenal ulcers (callous).

CASE LXI.—(No. 926.) Male, thirty-nine. Local and ether; scar anterior wall duodenum; glands in omenta; resection (16.26 cm.); subhepatic drain. *Diagnosis.*—Callous ulcer anterior wall duodenum very near pylorus, with hæmorrhagic infiltration around; hæmorrhagic areas in stomach.

CASE LXII.—(No. 938.) Male, thirty-two. Local; scar anterior wall duodenum; adhesions to gall-bladder; glands in omenta; resection (15.25 cm.). *Diagnosis.*—Two duodenal ulcers (callous on anterior face; posterior more superficial); duodenitis.

CASE LXIII.—(No. 963.) Male, fifty-seven. Spinal; deforming scar anterior wall duodenum; adhesions with liver and gall-bladder; thickening posterior wall; easy mobilization; resection (18.27 cm.); subhepatic drain. *Diagnosis.*—Two ulcers (anterior and posterior) united by a fissure (hour-glass ulcer); duodenal stenosis; duodenitis.

CASE LXIV.—(No. 970.) Female, forty-five. Local; scar on anterior wall; thickening superior margin; duodenal stenosis; resection (15.30 cm.); subhepatic drain. *Diagnosis.*—Ulcer anterior wall duodenum penetrating in gastrohepatic omentum; duodenal stenosis.

CASE LXV.—(No. 977.) Male, twenty-four. Spinal; extensive thickening superior margin duodenum; adhesions with gall-bladder; difficult mobilization; resection (11.26 cm.); subhepatic drain. *Diagnosis.*—Callous ulcer anterior wall penetrating in small omentum.

CASE LXVI.—(No. 978.) Male, thirty-six. Spinal; anterior wall of duodenum and gall-bladder form a hard swelling; difficult mobilization, during which ulcer of anterior wall of duodenum penetrated in the coats of gall-bladder opened; resection (21.31 cm.); subhepatic drain. *Diagnosis.*—Large ulcer anterior wall duodenum penetrating; duodenal stenosis; small ulcer posterior wall duodenum.

CASE LXVII.—(No. 1030.) Male, twenty-four. Spinal and ether; thickening posterior wall duodenum; head of pancreas hard; periduodenal adhesions; difficult mobilization of duodenum during which posterior ulcer was opened; resection (15.30 cm.);



## SYSTEMATIC TREATMENT OF DUODENAL ULCER

subhepatic drain. *Diagnosis*.—Two ulcers in posterior wall; one penetrating in pancreas; duodenitis; moderate duodenal stenosis.

CASE LXVIII.—(No. 1067.) Male, twenty-nine. Spinal and ether; small epigastric hernia; gastrectasia; perigastritis and periduodenitis; duodenum is fixed to under surface of liver; difficult mobilization of duodenum; resection (18.31 cm.); subhepatic drain. *Diagnosis*.—Very large ulcer penetrating in omentum gastrohepaticum; duodenal stenosis; duodenitis-gastritis.

(1934 January and February)

CASE LXIX.—(No. 36.) Male, twenty-one. Spinal; scar on anterior wall duodenum; posterior wall thickened; perigastritis and periduodenitis; glands in omenta; duodenal stenosis; resection (14.25 cm.); subhepatic drain. *Diagnosis*.—Two duodenal ulcers (posterior larger and callous) connected by a cicatricial ridge; duodenal stenosis; gastritis.

CASE LXX.—(No. 51.) Female, thirty. Spinal; scar on anterior wall duodenum; head of pancreas hard; glands in omenta; resection (15.25 cm.). *Diagnosis*.—Two superficial duodenal ulcers; moderate degree of stenosis.

CASE LXXI.—(No. 57.) Male, fifty-one. Spinal and ether; head of pancreas hard; periduodenitis and perigastritis; glands in omenta; resection (16.27 cm.); subhepatic drain. *Diagnosis*.—Callous ulcer of posterior wall duodenum; multiple superficial ulcers and small scars; umbilicated papulae on gastric mucosa.

CASE LXXII.—(No. 110.) Male, twenty-four. Spinal and ether; thickening on anterior wall of duodenum with disseminated area of hyperaemia; periduodenitis and perigastritis; mobilization of duodenum difficult; resection (25.12 cm.). *Diagnosis*.—Two small duodenal ulcers (anterior and posterior); purple color of gastric mucosa.

CASE LXXIII.—(No. 111.) Male, twenty-one. Local; scar and hyperaemia anterior wall duodenum; periduodenitis; glands in omenta; resection (13.27 cm.); subhepatic drain. *Diagnosis*.—Callous ulcer anterior wall (like a coma); superficial ulcer posterior wall; gastritis.

CASE LXXIV.—(No. 131.) Male, fifty. Local; thickened posterior wall of duodenum and head of pancreas; strong adhesions with gall-bladder; duodenal stenosis; difficult mobilization; resection (14.28 cm.); subhepatic drain. *Diagnosis*.—Large callous ulcer penetrating in pancreas; gastritis; duodenal stenosis; small gastric ulcer.

CASE LXXV.—(No. 187.) Male, thirty-four. Local; strong adhesions between duodenum, liver and gall-bladder; duodenal stenosis; resection (15.30 cm.); subhepatic drain. *Diagnosis*.—Callous ulcer anterior wall; small ulcer posterior ulcer; duodenal stenosis.

CASE LXXVI.—Male, thirty-four. Local; deforming scar anterior wall duodenum; periduodenitis; resection (16.27 cm.); subhepatic drain. *Diagnosis*.—Callous ulcer anterior wall duodenum.

## PYLOROPLASTY: ITS PLACE IN THE TREATMENT OF PEPTIC ULCER\*

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THE first operations on the stomach were undertaken for the relief of obstruction. The pioneer in gastric surgery was Billroth<sup>1</sup> who, in 1881, resected the pyloric portion of the stomach for carcinoma and then reunited the stomach and duodenum. This is the Billroth I operation of today.

According to DaCosta,<sup>2</sup> gastroenterostomy was proposed in 1881 by Nicoladoni,<sup>8</sup> an assistant to Wölfler,<sup>9</sup> both of whom were working in Billroth's clinic. Wölfler employed the operation with good result in a case of advanced carcinoma of the pylorus, and gave the operation its name.

The first pyloroplasty was probably that devised by Loreta<sup>6</sup> in 1882. He dilated the constricted pylorus with the fingers. In 1886, Heineke performed a plastic operation on the pylorus for stricture; this consisted of dividing the strictured portion on an axis parallel with the lumen and closing the opening in a transverse direction. Then, in 1887, Mikulicz,<sup>7</sup> working independently and without knowledge of the work of Heineke, reported the use of the same procedure. The operation became known as the Heineke-Mikulicz pyloroplasty.

Although gastroenterostomy and pyloroplasty were designed and carried out at about the same time, nevertheless gastroenterostomy early took the lead in the treatment of peptic ulcer. Probably the chief reason for this was that in those days operation for peptic ulcer usually was not performed until late in the course of the disease, and often not until the presence of obstruction made the demand for surgical treatment imperative.

Finney,<sup>3</sup> in 1902, published reports of cases in which he had carried out pyloroplasty. This gave impetus to the use of that type of operation for the treatment of peptic ulcer. In two of his five cases he excised as much as possible of the scar tissue on each side of the incision in order to limit subsequent contraction of the cicatrix.

Meanwhile, two outstanding features of the situation in regard to peptic ulcer were slowly but surely leading to the development of conservative procedures that might eliminate the possibilities of unsatisfactory relief following operative measures: (1) surgical procedures were coming to the fore in the treatment of duodenal ulcer, and (2) occasionally gastroenterostomy was followed by the development of secondary ulcers. Consequently, in the next thirty years, various plastic operations were devised and tested. Some included excision of the lesion; others left it undisturbed. Spasm of the

## PYLOROPLASTY FOR PEPTIC ULCER

pyloric muscle was recognized as a formidable factor in the production of the symptoms. Often the treatment included some form of operation on the sphincter. Cutting through the sphincter, removing a triangular segment, and numerous plastic procedures were tried with the hope of eliminating spasm and of changing the physiological processes involved, but none of these gave invariably satisfactory relief.

Horsley,<sup>4</sup> in 1919, modified the Heineke-Mikulicz procedure. By making the incision twice as long on the gastric as on the duodenal side of the pylorus, he was able to excise the lesion, and then he made the closure in the transverse direction.

The first local operation for duodenal ulcer at The Mayo Clinic was carried out in 1896, and was probably a Heineke-Mikulicz procedure. Later, the technic of Finney was followed, and other modifications were used. The results obtained by these operations were not entirely satisfactory, and here, as elsewhere, gastroenterostomy gained in favor. In a short time, however, local excision of the ulcer was suggested as a better means of controlling the situation, and in 1902 this began to be carried out in specific instances. In 1922, a series of 141 cases was reported in which excision of the ulcer was all that was done. Some of the patients continued to have dyspepsia. It was recognized that certain of the symptoms attending duodenal ulcer were due to the tension and spasm resulting from the action of the pyloric sphincter muscle. Furthermore, the possibility that these activities might be partially responsible for the formation of the lesion was beginning to claim attention. In order to improve the results that were being obtained, a more extensive operation on the pylorus was planned. This consists of excision of a rectangular portion, including the cap of the duodenum, the ulcer, and the anterior two-thirds of the pyloric sphincter muscle. The normal continuity of the gastro-intestinal tract is then reestablished by the closure, which is a gastroduodenostomy. The exposure for this local operation is not difficult to accomplish if it is not attempted in cases in which the ulcer is at some distance from the pylorus, or if the duodenum is too firmly fixed to be readily mobilized. The technical steps of the procedure are neither intricate nor arduous if the tissues are well exposed. This operation not only removes the ulcer, but it eliminates all possibility of pyloric spasm. The physiological reactions of the stomach and duodenum are changed, for the concentration of acids is lowered.

This procedure permits better inspection of the duodenum than other conservative operations. It has shown that, in many instances, multiple lesions were present. If an ulcer is found on the posterior wall the excision can be extended to include this lesion, leaving only a strip of the posterior wall and its mucous membrane; an area of duodenitis or a small ulcer in this area may be left undisturbed.

*Indications and Contraindications for the Operation.*—It is certain that in some instances duodenal ulcer heals spontaneously. But healing may progress slowly and poorly and, after healing, the lesion may tend to become

active at intervals. Once a duodenal ulcer is present, the patient is a potential victim of ulcer throughout life. The chronicity of this disease is one of the principal justifications for early surgical intervention. However, if the risk of the operation were not low, one would not be justified in advising it early in the course of the disease, for it must be remembered that in some cases the procedure will be undertaken for the relief of symptoms which are more annoying than disabling. There are certain patients, such as farmers, laborers, traveling salesmen, and others who will not be able to carry on their duties because they are intermittently incapacitated by return of the symptoms. Even if the economic factor could be disregarded there is another feature of the situation which should not be overlooked. Delay in obtaining adequate treatment affords an opportunity for the development of complications which constitute an additional risk at the time surgical intervention is finally undertaken. Increasing experience with this disease enables us to recognize most of the cases in which surgical treatment will eventually be demanded. If this is undertaken before there has been much fixation, contracture, pouching, or narrowing of the duodenum, the local operation can be carried out readily.

Our observations indicate that, if patients are of certain types, particularly if they are of nervous temperament, the ulcer is likely to recur. Such persons find it difficult to adapt themselves to a medical and dietary regimen, and for the same inherent reasons, surgical treatment may be disappointing. One should be slow to advise surgical intervention if the patient is highstrung, if he maintains poor habits of living, or if there is a functional factor present. It is in this type of person that jejunal ulceration occurs most commonly after gastroenterostomy. Even extensive resection does not insure against recurrent ulceration, and if this should take place, the surgical approach is much more difficult at the second operation than it would have been had local excision been made. If the patient is obese, any operation may be attended with considerable danger, and therefore either excision of the ulcer or gastroenterostomy should not be undertaken unless some complicating factor makes surgical treatment imperative. In the presence of obesity, moreover, a gastroenteric stoma may not function well.

Local excision of the lesion, taking out the greater portion of the pyloric sphincter, is the operation that should be carried out on young persons if that procedure is possible. It entirely eliminates the possibility of the formation of jejunal ulcer, and the symptomatic relief is commensurate with that of gastroenterostomy. However, if the local operation is not applicable because of inaccessibility of the duodenum, we do not hesitate to carry out gastroenterostomy. We do not feel justified in making an extensive gastric resection for duodenal ulcer when conservative measures give such good results, with a mortality rate of 1 per cent. or less. The severe gastritis observed by surgeons in other countries undoubtedly accounts for the extensive resections that they sometimes carry out.

The need for surgical treatment may be increased by the presence of obstruction, hæmorrhage or evidence of perforation.

## PYLOROPLASTY FOR PEPTIC ULCER

Patients with obstructive phenomena due to duodenal ulcer should undergo surgical treatment, but the exact nature and extent of the procedure will depend on several factors: relief of obstruction in the upper part of the gastro-intestinal tract is imperative, for it may give rise to severe toxæmia that will progress to gastric tetany, toxic nephritis, and finally death. Pre-operative preparatory treatment should always be given, particularly if the obstruction is marked or if the chemical constituents of the blood have been altered appreciably. Even in some of the cases in which there is marked obstruction, it will be found that the duodenum can be mobilized sufficiently to allow excision of the lesion and pyloroplasty, without unwarranted risk. If these conditions do not obtain, then gastroenterostomy is the better procedure.

Hæmorrhage caused by duodenal ulcer varies widely in severity, frequency, and duration. During the first hæmorrhage, treatment should practically always be expectant because the hæmorrhage is rarely fatal, because the operative mortality is likely to be higher than if the condition is left undisturbed, and, furthermore, because an emergency operation does not often permit an accurate differential diagnosis to be made. Even if surgical intervention is undertaken during the stage of active bleeding, it may be difficult to find the point of origin of the hæmorrhage. In some cases, the bleeding occurs from an area of inflammation in which there is no definite ulceration, although the history may have been typical of ulcer. In most of these cases röntgenological examination has disclosed definite deformity of the duodenum. At times, medical and dietary treatment should be carried out for two or three weeks before any operation is undertaken. This will give the acute inflammatory process a chance to subside to some extent, which affords the surgeon a better opportunity to attack the ulcer directly. In some cases it will be advantageous to give transfusions of blood, in addition to carrying out the other measures. Although there may be some persisting cedema and thickening of the tissues (duodenitis) after excision of the cap of the duodenum and the major portion of the pyloric sphincter, nevertheless the patients usually obtain satisfactory relief. Some of them adopt a carefully regulated diet for a short time, and feel that this hastens complete recovery.

Perforation complicates the problem. The process may be sufficiently retarded to result in protective slow fixation, or it may be sudden, and the situation may become acute. If the patient is seen within a few hours after actual perforation has taken place, it may be possible to excise the ulcer and make closure by gastroduodenostomy. However, closure of the opening resulting from the perforation may be all that is advisable at the time. If nothing more than this is done, further operation may be required later.

If a jejunal ulcer forms following gastroenterostomy, it is best to restore normal gastro-intestinal continuity just as nearly as is possible. This is accomplished by taking down the gastroenteric stoma, closing the openings in the stomach and jejunum, excising the original duodenal ulcer with the anterior two-thirds of the pyloric sphincter, then completing the operation as



a gastroduodenostomy. Should the duodenum be so immobile that the risk of removing the cap of the duodenum with the primary lesion is appreciably increased, it is better judgment to leave the ulcer undisturbed after taking down the gastroenteric stoma. In this event, adherence to a carefully regulated dietary and medical regimen for a period of time is especially indicated. If the duodenal ulcer becomes active after this procedure, resection of the stomach may be indicated.

Some patients will have hypertrophy of the muscle of the pyloric sphincter without any definite ulceration of the mucosa, and yet the distress which they describe is more or less characteristic of ulcer. It has been found that the local operation will relieve their symptoms. Complications are less common following this local operation than they are after other procedures on the stomach and duodenum. The majority of those that do occur are pulmonary.

The operation is done without clamps. Therefore some soiling from the content of the stomach and duodenum is inevitable; yet there is practically no difficulty with the suture line and peritonitis, evidently because of the preservation of the blood supply from the posterior wall. The vulnerable point in resection is the liability of leakage from the duodenal stump.

In a few cases, after excision of the cap of the duodenum and the anterior portion of the pyloric sphincter muscle, a second operation has been necessary because of pain or symptoms suggestive of intermittent obstruction. In each case the lumen has been found to be ample; the disturbance has resulted from adhesion of the duodenum to the scar, and complete relief has been obtained after the intestine has been freed. Furthermore, there is never any contracture such as has been observed after the Billroth I operation, and the stomach empties promptly.

*Results.*—Satisfactory relief will be obtained in 85 to 90 per cent. of all cases, following either gastroenterostomy, or excision of the cap of the duodenum with the lesion, and two-thirds of the pyloric sphincter muscle, and closing as a gastroduodenostomy. However, when this local operation is applicable it offers additional advantages which make it the preferable procedure, especially in young persons, for it removes the lesion, minimizes the possibility of future bleeding, and does not impose a situation favoring the formation of jejunal ulcer.

The excision of the anterior portion of the pyloric sphincter muscle, as we carry it out, destroys its function. It is true that slight regurgitation of the duodenal content may occur, but this is of little if any consequence. At the close of the operation the normal continuity of the stomach and duodenum is reestablished, the physiological reactions are changed, and there is almost no likelihood of the formation of a new ulcer.

The application of this local operation has been extended cautiously and in accordance with our experience. It must be remembered that the disturbances due to ulcer are usually seasonal or intermittent, and that many of the patients with this disease do not present themselves for treatment until after they have had symptoms for a long time and the incidence of fixation or of some other

## PYLOROPLASTY FOR PEPTIC ULCER

complication has increased. Nevertheless it has been found that the procedure can be carried out in more than 50 per cent. of all cases of duodenal ulcer. The uniformly satisfactory immediate and ultimate results that have been obtained certainly recommend the operation, but the realization that it minimizes the risk of similar disturbance in the future establishes it as the one of preference in the majority of cases of duodenal ulcer.

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## APPENDICITIS

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IT is wellnigh fifty years since Fitz wrote his classical paper on appendicitis. He established once for all the fundamental fact that the vast majority of infections in the right lower quadrant of the abdomen have their origin in the vermiform appendix. It is literally true that no other disease has occupied the minds of both the profession and the public so much during the past half century as appendicitis. The literature on the subject almost baffles analysis. Certain contributions, however, have been outstanding—those of McBurney and of Murphy on the necessity for prompt operation when the case is diagnosed early; that of Oschner on the value of expectant treatment when the case is seen on the third or fourth day of the disease.

The principles of minimum interference with the peritoneum, the value of fluid replacement, the advantage of the so-called Fowler position, the benefits of enterostomy when a secondary intestinal obstruction develops, these have all helped to save lives. We are faced, however, with the distressing situation that, in spite of all this intensive study and attention, in spite of our modernized hospitals, our greatly improved transport facilities, and the immense increase in the number of operating surgeons, the death-rate from appendicitis is, if anything, higher now than it was twenty, or even thirty, years ago.

The number of cases of acute appendicitis operated on has increased many-fold during the past twenty years. The percentage death-rate in the operated cases has decreased notably. Why then should the total death-rate be as high as ever? Personally I have no doubt as to the reason. It is this. Whilst the number of cases diagnosed and operated on early has increased remarkably, the fulminant and fatal type has been overlooked as heretofore. In the vast majority of the cases operated on early the patient would have recovered in any case. What is wanted is a true understanding of the pathology and the clinical picture in the fulminating and, if neglected, fatal case.

Twenty years ago I brought forward both clinical and experimental evidence that the dangerous case of appendicitis was not an inflammation but an obstruction of the appendix; that it was a closed loop intestinal obstruction, and that the symptoms and the dangers corresponded rather with those of an internal strangulation than with those of an inflammatory condition. I suggested that we teach the student that there are two acute diseases of the appendix—one an inflammation of its wall, a relatively harmless disease; the other an acute appendicular obstruction, liable to rapid gangrene and perforation, followed by diffuse and often fatal peritonitis.

## APPENDICITIS

The essential clinical features of the obstructive type were, as one would expect, intermittent colicky pain with vomiting but unassociated with any rise of pulse rate or temperature during the first six to twelve hours. The fulminating character of the process depended on the content of the appendix at the moment of obstruction. If the appendix were more or less empty the process was relatively slow and mild; if, on the other hand, the appendix contained an appreciable quantity of fecal matter, rapid distention of its lumen and tension-gangrene of its wall occurred. The whole process of obstruction, distention, gangrene and perforation might occur in six to eight hours, before any walling-off adhesions had had time to form. When perforation occurred the fetid content of the distended appendix, swarming with bacteria, many of them anaërobic, was spilt over the free and unprepared peritoneum with disastrous effect.

The difference between operation just before perforation and a few hours after is that between a fair certainty of recovery and a probable chance of death.

I have since learned that I was not the first to draw attention to the paramount importance of the obstructive factor. Van Zwalenburg, in America, and Campbell, in Ireland, had both published papers in local medical journals on the subject. The former still believes that all cases of inflammation of the appendix are primarily obstructive. With this I cannot agree, but at the same time I very gladly acknowledge the signal service he has done in proclaiming, in and out of season, the importance of the obstructive factor.

If we analyze the mortality figures from hospitals where a careful record of the condition of the appendix at operation is made, we find that over 90 per cent. of the deaths occur in cases where a gangrenous and perforated appendix is found, *i.e.*, in the cases of appendicular obstruction. Our duty is therefore clear. Firstly, we must impress on our students, undergraduate and graduate, that, in the dangerous type of obstructive appendicitis, colic and vomiting with a normal pulse and temperature characterize the early stage, when operation is life-saving. We must make them understand the pathology, and the reason for this clinical picture.

Secondly, we must, through all legitimate agencies, impress on the public that colic and vomiting, without fever, often mean a dangerous type of appendicitis, that a dose of castor oil makes bad worse, and that in all such cases a doctor should be called in without a moment's delay. So will we, in course of time, bring these critical cases to timely operation and save many young and useful lives.

I have referred so far exclusively to diagnosis, based on a knowledge of pathology, as I believe it is by far the most important line of endeavor whereby we may reduce mortality. I consider, however, that just as early operation is beneficent and life-saving in these obstructive cases, so it may be meddlesome and dangerous in the case seen late, where nature has walled

off the infection and an inflammatory lump has formed. Such cases should be kept under observation, if possible in a hospital, and, if the pulse rate and temperature do not rise, permitted to resolve. Where a large abscess has developed by the time the patient is first seen, it should be opened by the shortest route, with the least disturbance of the bowel, and no search should be made for the appendix if it is not present in the wound. In all such cases surgery should be conservative and restrained.

*Anaërobic Danger.*—When we are dealing with a perforated, gangrenous appendix we find consistently that anaërobic bacteria are present in large numbers. The peritoneum has a considerable capacity for dealing with such bacteria if they be not of overwhelming virulence or number. The abdominal wall, however, especially in stout subjects, is peculiarly susceptible to anaërobic infection, and by our operative interference, whilst we may rid the patient of a gangrenous, infected organ and of some of its escaped content, and whilst we may drain the pelvic pouch, we are apt to forget that we have of necessity infected the tissues of a hitherto clean abdominal wall, and added the risk of a cellulitis to that of peritonitis. In all such cases we have, for some years, left the abdominal wound largely open and lightly packed with gauze. We have used no catgut sutures, which might serve as pabulum for anaërobes, but depended on looped silkworm-gut sutures, which are later removed. Through a fine rubber tube, laid along the depth of the abdominal wound and brought out through the dressing, 5 cc. of hydrogen peroxide is instilled every two hours. In addition the patient is given 40 cc. of anti-Bacillus *Welchii* serum at the time of operation.

The increase in comfort and well-being of patients so treated during the first four post-operative days, compared with a series of patients where the abdominal wound is closed round the tube, is remarkable. In a bad case the presence or absence of cellulitis of the abdominal wall may be the deciding factor.

*Secondary Intestinal Obstruction.*—Many patients, who have successfully resisted the peritoneal infection, have died of intestinal obstruction. Whilst it is admitted that in severe general peritonitis there may be a paresis of the small intestine—an adynamic ileus which may precipitate the fatal issue—it is none the less true that in the majority of cases of post-operative obstruction in appendicitis, there is a mechanical factor, usually in the lower ileal coils, and that an enterostomy or enterocolostomy will give relief. The essential difference in the two types of obstruction is that in the adynamic type the pulse is accelerated, and intermittent pain is absent, whilst in the mechanical type the pulse, as a rule, is slow and the patient has some degree of colicky pain. A jejunostomy made by the Witzel method with a tube passed through the omentum will tide the patient over the few critical days whilst the adhesions are forming.



## APPENDICITIS

### SUMMARY

(1) The deaths in appendicitis are almost all in the obstructive type of the disease.

(2) This type must be clearly differentiated, both in regard to its pathology and to the clinical picture to which it gives rise.

(3) The pulse and the temperature are unaffected in the early and curable stage of obstructive appendicitis.

(4) Late cases with a lump should be treated expectantly.

(5) Anaërobic cellulitis of the abdominal wall may be a cause of death in gangrenous perforated cases. Open-wound treatment and *Bacillus welchii* anti-serum are recommended in such cases.

(6) Jejunostomy is a life-saving measure when obstructive symptoms with colic develop.

## THE RADICAL SURGERY OF CANCER OF THE PANCREAS

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THE perusal of relevant surgical literature seems to demonstrate that the successful extirpation of a malignant tumor of the pancreas is a rare event, and little evidence is forthcoming that prolonged survival may follow an operation of this character. Records of the removal of cystadenomata of the pancreas, albeit not "as thick as autumnal leaves that strow the brooks in Vallombrosa," are at any rate not very sparse in number; but malignant neoplastic disease of this organ scarcely ever appears to have permitted any other surgical interference than some palliative anastomosis for obstructive symptoms of a secondary character.

Almost seven years have now elapsed since the removal of a massive carcinoma of the body of the pancreas was performed in the case under consideration; and a recent visit of the patient in an excellent state of health, and in possession of boundless mental and physical energy, prompts the presentation of this note. The following account does not purport to be a narrative of some stupendous or venturesome operation, but merely embodies a hope that others may be encouraged to radical measures should it be their fortune to encounter a similar set of conditions. Moreover, the possibility of an enduring cure as a recompense for surgical fortitude would seem to justify a bolder attitude than has been customary in this disease.

The authority of Mikulicz has for long invested the pancreas with the reputation of a surgical "noli-me-tangere," but recent experiences in the surgical treatment of hyper-insulinism or dys-insulinism have demonstrated the safety of the removal of a B-celled adenoma of the pancreas,<sup>1,2,3,4,5,6</sup> or of even the ablation of considerable portions of the organ.<sup>7</sup> Apart from an increasing number of cases of partial pancreatectomy,<sup>6,7,8</sup> where varying amounts have been removed for hypoglycæmia, and where the degree of permanent benefit following this cruder type of operation has on the whole disappointed, the quota of localized tumors of the pancreas removed for the relief of this syndrome has now all but attained double figures. Of these tumors at least two<sup>1,6</sup> have proved to be carcinomata of the islets of Langerhans, which in contra-distinction to the normal habits of cancers of the secreting glands have retained their normal property of secreting insulin. The results of the surgical removal of these localized tumors in hypoglycæmia have furnished a dramatic contrast to those attained by the more vague ablation of varying portions of the gland. Surgical enterprise in this class of case deals of course with a gland which in its gross anatomy appropinquates normality; but in malignant neoplasms, apart from the two or three

## CANCER OF THE PANCREAS

small Langerhansian carcinomata which have up to this date been successfully excised, the fixity of the tumor and the infiltration and involvement of important, perhaps vital, adjacent structures add to the anxiety of the undertaking. Nevertheless, it is of interest that even in cases where the tumor has attained considerable magnitude, mobility may still sometimes be retained, and it is noteworthy that even in a case of carcinoma of the head of the pancreas, for which three palliative operations of diverse nature had been performed at another institution, and in which the diameter of the tumor was nearly three and a half inches, the affected portion of the pancreas was found at autopsy to still retain its mobility, showed no involvement of its portal vein or its parent tributaries, and was remarkable for a complete absence of any metastases in the body. The hope had indeed been entertained that something of a radical character might have been done in this case; but the preliminary operations which had already been performed elsewhere, and which appeared to have been responsible for the very grave type of anæmia which brought her under my notice, were not those best calculated to supplement any proposed pancreatectomy; and from a minor undertaking she unfortunately died.

The notes of the successful case of sub-total pancreatectomy which forms the basis of this paper are briefly as follows:

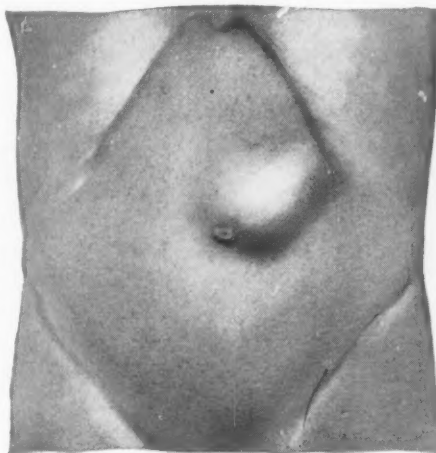


FIG. 1.—Appearance of abdomen before operation.

D. R. McL., male, fifty-four years of age, was referred to me for a tumor in the left hypochondrium and left umbilical region. The patient had always suffered from mild indigestion and had all his life been careful about his diet. For a month or two before he came under my observation he had felt very tired, and had found that his administrative work fatigued him more than before. He then noticed a lump under the left rectus abdominis, and found that as a result of certain movements of his body he could displace the tumor under the left costal arch, so that it could not be felt; this may have accounted for the size which the mass had attained before it attracted his attention. The patient was of spare conformation, and when the abdomen was inspected from varying angles, and under various conditions of light, the outline of the tumor could be made out on the surface of the body. (Fig. 1.) Some mobility of the tumor could be demonstrated, and marked pulsation was present. The stomach seemed to be displaced downwards, and the resonance of the latter contrasted with the dull note of the tumor and the liver above. A systolic murmur was heard over the mass; the Wassermann was negative. Possibly an unwonted experience of the surgical treatment of several aneurisms within the few months which preceded the date at which the case came under my observation may have accounted for the diagnosis of an abdominal aneurism, a diagnosis made in the presence of a negative Wassermann reaction and alas, on faulty clinical observation and too hasty conclusion.

Laparotomy was performed in the summer of 1927, the abdomen being opened by a left paramedian incision of generous length; the position of the stomach was low, and the tumor presented between the liver and the lesser curvature. (Fig. 2.) Pulsation was well-marked; and the elementary and unforgivable mistake of failing to differentiate between communicated and expansile pulsation—*horresco referens*—was committed, even on the operating table. Arrangements had been made for "wiring" the supposed aneurism; and three times the trocar-cannula of a G. H. Colt's ingenious apparatus was plunged into the tumor: but "the erring blade found bloodless sheath."

It became apparent that the swelling was a solid tumor and that pulsation was communicated to it by the aorta underneath. The approach to the tumor was facilitated

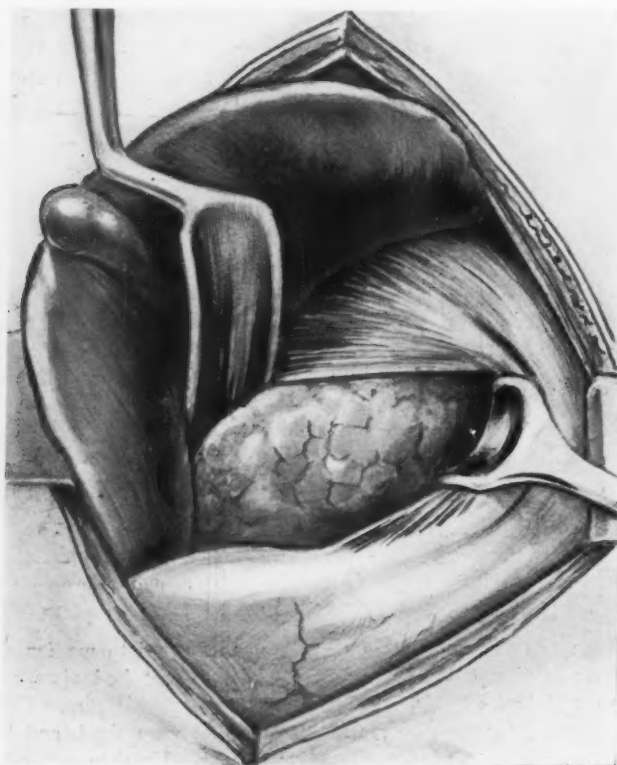


FIG. 2.—Cancer of body of pancreas presenting upon lesser curvature of stomach.

by a transverse incision dividing the left rectus abdominis and the mass was slowly, laboriously, and not without some difficulty and anxiety freed from its surroundings. The dissection was commenced at the tail, the very extremity of which was not involved; this minute fragment of the pancreas in contact with the spleen was retained, as also the spleen itself, despite the fact that as the operation proceeded the splenic artery was widely exsected and the splenic vein was found to be so implicated in the mass that a linear strip of that vessel had to be removed. No subsequent sequel referable to the spleen made one regret the decision to conserve that organ. The tumor in its growth was found to have altered the normal relationship of splenic artery and splenic vein, the latter being uppermost. (Fig. 3.)

In addition to the removal of the upper circumference of the expanded splenic vein, the left moiety of the lower portion of the portal vein also required ablation. (Fig. 4.)

## CANCER OF THE PANCREAS

The two veins were very dilated and flattened, and a short intestinal clamp was placed longitudinally on each, and the tumor cut away, the projecting edges of the vein being sutured afterwards and the clamps removed. This was very easily accomplished by a running stitch; this somewhat alarming description completely misrepresents the difficulties of the actual operation, which was by no means a desperate procedure. At the termination of the undertaking, only that part of the pancreas embraced by the concavity of the duodenum appeared to remain.

A drain was inserted down to the retroperitoneal space whence the tumor had been delivered. The operation was of long duration, and the "capital" portion of the pancreas

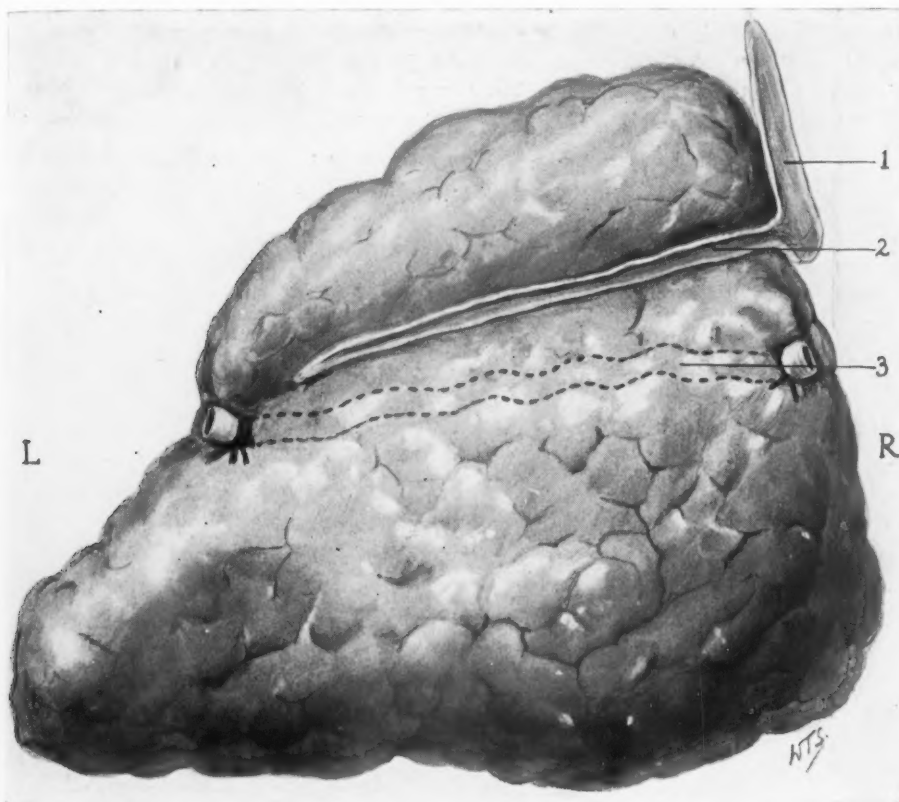


FIG. 3.—Carcinoma of body of pancreas after removal. Note altered position of splenic artery and vein. (1) Portal vein. (2) Splenic vein. (3) Splenic vein.

remaining was sutured over with no great accuracy. My anxieties as to the adequacy of the small amount of pancreas which I had left behind were allayed by the assurances of my colleague, Dr. Izod Bennett, whom I chanced to meet in the nursing home at the end of the lengthy operation. The patient made a good recovery; and the correctness of my colleague's prognostication has been confirmed by the subsequent history of the case, for at no time has the patient shown any sign of pancreatic deficiency. My fears, however, might have been allayed even during the operation had I been possessed of the knowledge that, according to Professor Bensley<sup>9</sup> of Chicago, perhaps the greatest authority on the histology of the islet tissue of the pancreas, a normal organ contains about one thousand times as much insulin-producing tissue as is necessary for normal needs. There was a considerable discharge of pancreatic juice for the first fortnight,



G. GORDON-TAYLOR

but the amount gradually diminished to almost vanishing point before the patient left the nursing home six weeks after the operation.

*Pathological Description.*—The tumor removed was about one and a half times the size of a closed fist, having a much greater vertical measurement towards its right end, whereas the left half of the tumor diminished in its diameter towards the tail. The surface of the mass was irregular and nodular: the consistency firm, and on section the tumor was not delimited from the normal pancreas, but appeared to infiltrate that portion of the organ which had been removed with the neoplasm.

Professor Baker, formerly of the Bland-Sutton Institute, Middlesex Hospital, and now Professor of Pathology at the University of Manchester, reported on the tumor as follows:

"Microscopically the tumor is a columnar-celled carcinoma. The epithelial cells are arranged in irregular sheets, and consist for the most part of single layers supported on a fine connective tissue. The tumor is primary in the pancreas, originating in a duct. The histological appearance suggests a slow-growing tumor of probably

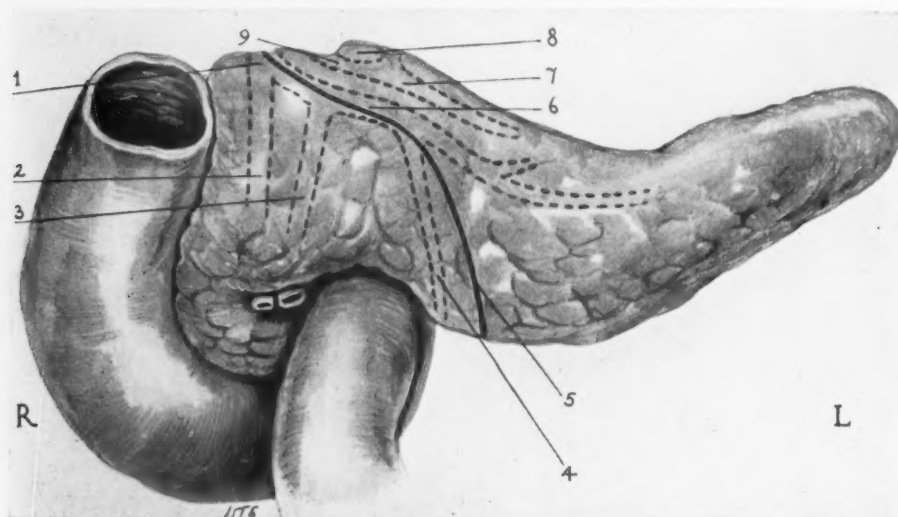


FIG. 4.—Sketch of pancreas to indicate the relation of line of section to the various structures in relation to the organ. The grooves on posterior surface of organ are indicated by dotted lines. (1) Groove for portal vein. (2) Groove for superior mesenteric vein. (3) Groove for superior mesenteric artery. (4) Line of section of organ at operation. (5) Groove for inferior mesenteric vein. (6) Splenic vein. (7) Splenic artery. (8) Coeliac axis. (9) Hepatic artery.

comparatively low malignancy. A lymphatic gland attached to the posterior part of the specimen was sectioned and showed no secondary deposits."

*After-History.*—In the very end of 1929, a visit from this man afforded the opportunity of investigating a patient who had suffered a sub-total pancreatectomy; he had by that time put on a stone in weight since his operation, and was heavier than he had ever been in his life. Certain researches on his metabolism were carried out at the Courtald Institute, Middlesex Hospital:

*Glucose Tolerance Test*

Resting	Blood Sugar
½ hr. after glucose.....	105 mgs. per 100 cc.
1 hr. after glucose.....	132 mgs. per 100 cc.
1½ hrs. after glucose.....	100 mgs. per 100 cc.
2 hrs. after glucose.....	76 mgs. per 100 cc.
	73 mgs. per 100 cc.

## CANCER OF THE PANCREAS

Urine Specimen	Before Glucose	1 Hour After	2 Hours After
Sugar.....	Nil	Nil	Nil
Volume.....	60 cc.	50 cc.	20 cc.
Specific gravity.....	1024	1024	1024
Rothera.....	Neg.	Neg.	Neg.
Gerhardt.....	Neg.	Neg.	Neg.

### *Blood Analysis*

Non-protein nitrogen.....	32.8 mgs. per 100 cc.
Urea.....	29.2 mgs. per 100 cc.
Calcium.....	9.6 mgs. per 100 cc.
Phosphates.....	4.7 mgs. per 100 cc.
Cholesterol.....	198.0 mgs. per 100 cc.
Alkali reserve.....	62.0 cc. C. O. 2 per cent

In cancer of the pancreas, the tumor is usually situated in the head or it extends diffusely over most of the organ. Tumors limited to the body are much less frequent, and the tail is rarely affected. Of 386 cases collected from the literature, Ewing<sup>10</sup> finds that 158 were diffuse, and 156 were limited to the head; 28 were in the body and 12 in the tail; the body of the organ is therefore the site of the tumor in only 7 per cent. of the cases. Although from a surgical point of view *cancer of the body of the pancreas* is the form which would seem to be most favorable for operative interference, the relative paucity of cases confined to this part of the organ necessarily limits the sphere of possible surgical activity; extirpations of malignant tumors of the head and tail are far more numerous in the literature.

*Cancer of the Head of the Pancreas.*—Formidable as are the anatomical relationships of cancer of the head of the pancreas, it is for malignant growth of this segment of the organ that radical surgery has until now been most often essayed. Oberling and Guerin,<sup>11</sup> in 1930, could collect from the literature twelve cases of partial pancreatectomy for cancer of the head of the pancreas.

Only the most scanty reference will be made to the efforts of those who have attempted by parsimonious and niggardly resection to deal with a malignant growth in this situation; the mortality of the operation has been very high, and the end-results most depressing in their monotonous story of speedy recurrence and rapid death. The surgeons concerned in the various operations were Ruggi,<sup>12</sup> Tricomi,<sup>13</sup> Franke,<sup>14</sup> Mauclaire,<sup>15</sup> Tuffier,<sup>16</sup> Ehrhardt,<sup>17</sup> Brentano,<sup>18</sup> Silvan,<sup>19</sup> Polya,<sup>20</sup> Kronlein,<sup>21</sup> Sherren,<sup>22</sup> and Gilbridge.<sup>23</sup> Sherren's case of a sarcoma is an exception in this dismal tale of woe.

Time may demonstrate that a more extended operation in the form of duodeno-pancreatectomy improves the end-results of those cases which are still operable when they come to laparotomy: the technic of this operation has hardly passed the experimental stage, and only two cases, those of Codivilla<sup>24</sup> and Michaux<sup>25</sup> have been reported in the literature where the procedure has been carried out in man.

One operation was performed a century ago, and the other—just over a

quarter of a century has elapsed since the second case was dealt with by this technic. Both of these cases ended fatally almost at once.

*Cancer of the Tail of the Pancreas.*—Oberling and Guerin<sup>11</sup> have collected eleven cases of removal of malignant tumors of the tail of the pancreas, of which four were carcinomata and seven were classed as sarcomata. Two of the four cases of carcinoma and two of sarcoma died after operation. The surgeons concerned in these undertakings were Malthe,<sup>26</sup> Franke,<sup>14</sup> Kleinschmidt,<sup>27</sup> Marogna,<sup>28</sup> who attacked carcinomata of the tail, whereas a sarcoma of the tail was removed by Trendelenburg,<sup>29</sup> Briggs,<sup>30</sup> Routier,<sup>31</sup> Malcolm,<sup>32</sup> Vincent,<sup>33</sup> Marogna,<sup>28</sup> and Marxer.<sup>34</sup> The only encouraging end-result is that of Marogna,<sup>28</sup> whose patient survived for eight years after the ablation of a hypernephroma of the tail of the pancreas; death, however, appears to have been due to recurrence, for ascites had been noted.

*Cancer of the Body of the Pancreas.*—Apart from the removal of small carcinomata of Langerhans' tissue in cases of hypoglycæmia there are now three cases of successful operative removal of massive cancer of the body of the pancreas. Grekoff's<sup>35</sup> patient, a woman of thirty-nine years, had been under his observation for nearly a twelvemonth before she actually came to operation, and during that period she had also consulted Bier, Korte, Israel, and Kuttner in Berlin, and Gosset in Paris. Diagnoses naturally varied greatly, but Grekoff and Korte thought the tumor to be pancreatic. At the operation, performed in April, 1913, the mass was found to have attained the size of two fists, and to be surrounded by a network of dilated vessels, especially large veins, the diameter of which in some parts amounted to as much as an inch. Despite the time the patient had been under observation the tumor proved to be very movable and occupied the tail, body, and part of the head of the pancreas; it was closely adherent to the mesocolon, a portion of which had to be resected to permit of the delivery of the tumor. Posteriorly it was attached to the vena portae, and to the superior mesenteric vein; and the tumor had to be dissected at this enormously dilated portal vein with a knife. No damage was done to this vessel, which was two inches wide. Numerous vessels required ligature, including the splenic vein. Only a small portion of the head of the pancreas remained after the tumor had been ablated, and the measurements of the segment remaining were stated with continental accuracy to have been three centimetres vertically and five to ten millimetres in thickness. The cut end of the pancreas was sutured in two layers. The abdomen was closed with drainage. The tumor measured 15 cm. x 11 x 8 cm. and weighed 412 Gm.: microscopically it is stated to have been a carcinoma. The malignant nature of the mass, however, has been questioned, partly owing to the very slow pre-operative development of the tumor, and secondly on the grounds that the histological description is not very convincing (Guibet). Symptoms of pancreatic deficiency appeared during convalescence, and required treatment by diet.

A successful operation for the removal of a cancer was performed by Serafini<sup>36</sup> upon a female of forty-five years. The operation was difficult,

## CANCER OF THE PANCREAS

and forceps had to be left in place to control the hæmorrhage. The splenic vessels were resected with the tumor. A pancreatic fistula remained, but gradually closed spontaneously. The woman, however, died two and one half years with muscle and bone metastases.

Roscoe Graham's case<sup>1</sup> was that of a small tumor only 1.5 cm. in diameter, removed by excision from the body of the organ, and the two cut surfaces were approximated by suture and the suture line reinforced by omental graft. It was only after microscopy that the tumor was found to be a Langerhansian carcinoma.

The successful operations for resection of the pancreas for a cancer of the body of that organ are indeed scanty in number, and apart from the present case reported here, there are only those of Grekoff and Serafini, and the small Langerhansian carcinomata of Roscoe Graham and of Judd, which last-named cases were operated on as benign tumors and subjected to a very limited removal. Even if Grekoff's case does not conform to all the criteria necessary to establish it beyond cavil as a carcinoma, the case here recorded makes an additional success to that reported by Serafini.

All writers<sup>37,38</sup> remark the mechanical difficulties of the operative removal of cancer of the pancreas, and it may be that this present case, now in the enjoyment of vigorous manhood, is only the exception that goes to prove the rule that "if boldness and good fortune are the operator's gifts, the result to the patient hardly justifies the means."

Possibly in the future some form of radiation will be found to cure these cases; but until then the record of this case may hearten others to extend their surgical skill and prowess to those luckless patients who may need the operative eradication of cancer of the pancreas.

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## PANCREATIC CANCER AND ITS TREATMENT BY IMPLANTED RADIUM

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FROM THE MIDDLESEX HOSPITAL

MY OBJECT in this paper is to state the result of the attempts I have made by means of implanted radium to bring into the field of therapeutics a form of cancer in which only rare surgical successes have been won by ablatory operations, attended by a very high degree of risk. Let me say at the beginning that I use the expression "pancreatic" cancer in a clinical rather than a strictly pathological sense to cover not only primary pancreatic cancer, but also those cases where a carcinoma, primary in the ampulla of Vater or the common bile-duct, or the main pancreatic ducts, extends into the substance of the pancreas, and so simulates a primary pancreatic growth.

It is but rarely, even during operation, that a clear distinction can be drawn between primary carcinoma of the pancreas and a secondary invasion of the pancreas by a growth starting in the common bile-duct, but fortunately for purposes of treatment while the distinction is difficult it is not important.

If the crater of an ulcer can be palpated through the anterior wall of the descending duodenum, it is almost certain that the growth is a true Vaterian one, but by the time such an ulcer can be felt the pancreas will certainly be involved, and the treatment is that for pancreatic carcinoma.

*Early Carcinoma of the Bile Papilla and Ampulla.*—According to Lauwers true ampullary carcinoma has little tendency to spread or to invade the glands. A cancer of this type, detected early, presents itself as a small firm nodule at the end of the common duct. For a case of this kind the right treatment is to open the duodenum, to excise the papilla with the growth by diathermy without penetrating through the outer coat of the duodenum, and to complete the operation by sewing up the incision in the duodenum. In the absence of jaundice cholecyst-enterostomy may be deferred.

These cases form a well-defined group in which excision seems the treatment of choice. They do not come within the ambit of this paper, and its conclusions do not apply to them.

It would prolong this paper unduly to give an account of the very difficult surgical problems presented by Vaterian cancer and of the attempts which have been made to deal with them by operative measures, especially as this branch of the subject has been recently dealt with by Dr. E. Lauwers, of Courtrai, in his paper "Traitement chirurgical du Cancer Vaterien" (*Journal de Chirurgie*, December, 1933).

W. SAMPSON HANDLEY

I will now describe the seven cases upon which this paper is based, and will afterwards discuss the conclusions to be drawn from them.

CASE I.—*Carcinoma of the pancreas with obstructed common duct. Interstitial radium treatment. Cholecystoduodenostomy. Complete temporary relief and restoration of health. Subsequent pyloric stenosis. Abdomen reopened by Mr. R. P. Rowlands and no sign of carcinoma found. Gastroenterostomy. Temporary restoration to health. Second laparotomy by Mr. Rowlands. Large carcinoma of the pancreas obstructing the portal and splenic veins. Death twenty-six months after the first operation.*

Captain B. C. H. was sent to me by Doctor Steen, of Ilford, October 19, 1925. The story of his case is a very interesting one, and is best told by means largely of original documents since both before and after radium treatment it came under the notice of skilled independent observers.

The first of these documents is a letter dated October 1, 1925, from Dr. J. F. Weir, of The Mayo Clinic, to the patient.

My dear Mr. H.:

Pursuant to your request I am writing at this time to outline our findings in your case. These are as follows:

When you registered, you gave a history of about six weeks' duration of painless, gradually deepening jaundice, associated with marked pruritus. During that time your appetite had been good and you had eaten well. However, you had lost between twenty and thirty pounds in weight. For the preceding six months you had noticed some impairment in your strength and ambition. Since the onset of the jaundice your bowels had a tendency to become somewhat loose at times but this became quite a marked feature while under our observation at the clinic.

Physical examination showed a marked jaundice. There was an evident weight loss. There was a mass in the right upper quadrant extending below the slightly enlarged liver which we interpreted as being a distended gall-bladder. The urine was negative except for the presence of bile. The blood count and the differential count were normal. The blood Wassermann and blood culture were negative. The gastric analysis showed a total acidity of 70, free hydrochloric 56, and a total quantity recovered at the end of one hour of seventy-five centimetres. Three stool examinations showed no parasites or ova, but oil or fat was present in excess. An X-ray examination of the chest was negative.

This investigation was made during the course of a journey to England. October 20, 1925, I saw Captain H. in London and wrote as follows to his medical adviser, Doctor Steen:

I saw yesterday your patient, Captain H. I found a deep resistance in the epigastric region level with the pancreas. The liver is rather down but its edges soft. I suspect, however, that its surface is nodular.

In my opinion the symptoms point to a malignant growth of the pancreas or of the biliary papilla of the duodenum. It is, however, possible that he is suffering from a chronic pancreatitis, and if that is the case he will certainly benefit by operation. I do not think that any further examination short of an exploratory incision is likely to clear up the diagnosis, and as he is a comparatively young man and has not lost his vigor I think it is worth while exploring the abdomen. The odds are, however, that the condition is a malignant one and I would not like to press the operation unduly, though it is the only chance.

October 21, 1925, I operated on the patient at the Ilford Emergency Hospital. The following are my notes at the time.

Usual gall-bladder incision showed a smooth normal liver with a very distended gall-bladder on the verge of necrosis. In the head of the pancreas behind

## RADIUM TREATMENT FOR PANCREATIC CANCER

and adjoining the pylorus was found a puckered mass about the size of a chestnut, evidently a carcinoma. The bile-duct was greatly distended from below the pylorus. Three tubes of radium 25, 12.5 and 12.5 mg. element were placed in the substance of the mass and left for twenty-four hours. Cholecyst-jejunostomy was performed. Patient stood the operation well. *Diagnosis*.—Carcinoma of the pancreas.

Captain H. made a good recovery and subsequently came under the care of Dr. A. M. Mitchell, of Guildford, who, October 5, 1926, wrote as follows:

History August 16, 1925.—Consulted doctor in Canada; he had jaundice, slight, and cutaneous irritation. *Diagnosis*.—Hemolytic jaundice. Liver and spleen not enlarged.

September 8, 1925.—At Mayo Clinic three weeks. No operation. Fractional test meals; X-ray; stools examined; *etc.* Mass in right upper quadrant of abdomen. Losing a pound a day.

October 17, 1925.—In England. Mr. Sampson Handley operated on October 22. Cholecystenterostomy. Three tubes of radium inserted over pancreas for twenty-four hours. Healed quickly. Pretty well, but some indigestion; resumed taking fats soon after operation and digested them.

April 30, 1926.—Returned to Canada. Fairly healthy state; ordinary meals.

Early August.—Acute indigestion and vomiting. Returned to England. Vomiting still persisting intermittently and losing flesh but I am doubtful if more than can be accounted for by the vomiting. No tumor felt and the X-rays show definite pyloric obstruction.

Mr. Sampson Handley does not return until November 10 and my feeling is that he should not wait until then, but should have his pylorus investigated and probably some sort of short circuit done for him.

October 8, 1926.—Mr. Rowlands saw patient and confirmed my opinion that something should be done immediately.

October 15, 1926.—Operation at a nursing home in Guildford. The stomach was large, œdematous and friable, obstructed near the pylorus probably as the result of adhesions. No ulcer was found and no sign of growth, but the whole of the pancreas was a little harder, but no larger, than normal. No evidence of malignant disease at present. Extensive adhesions on the right side of the abdomen. Posterior gastro-jejunostomy performed.

November 30, 1926.—Dr. Mitchell writes to Mr. Rowlands:

I ought to have let you know before this what a complete success your operation on Captain H. was. He has made an uninterrupted recovery and is slowly but steadily putting on flesh.

Next comes a letter from the patient himself.

January 8, 1927.

You will no doubt recall performing an operation cholecyst-jejunostomy upon me in about October 23, 1925, and will have your records of my condition at that time.

I returned to Canada in April of last year feeling very well indeed—my weight being 244 pounds.

About the beginning of August my health began to fail again with bad indigestion, vomiting and loss of weight. Under the impression that cancer was developing I returned to London in early September, and found that you were then in the United States.

After a preliminary period I was operated upon by Mr. Rowlands, of Guys, the operation being a short circuit of the stomach—the trouble being due to adhesions. Mr. Rowlands' report of my present condition is very cheering to me,

W. SAMPSON HANDLEY

as he could find no trace of cancer development at the time of the operation, October 15, 1926.

My present weight is nine stone and ten pounds, showing a steady increase all the time, and I feel remarkably well.

The story is completed in the following letter from the late Mr. R. P. Rowlands, whose recent loss British surgery has to deplore:

December 21, 1927.—I am sure that you will be interested to know the further history of Captain H., for whom you performed cholecyst-duodenostomy some years ago. I performed gastro-jejunostomy a little over a year ago for duodenal stenosis, when you were away in America. Since then I have opened a posterior sub-diaphragmatic abscess in August this year. He went on having rigors occasionally, and lately these became much more frequent and severe, and a little jaundice developed. Lord Dawson saw him again and it was ultimately decided to explore the abdomen in the hope of finding a stone, or other removable obstruction, in the common bile-duct.

I explored him yesterday at Guildford. I am sorry to say that there was a large growth in the head of the pancreas, completely obstructing the portal vein, the common bile-duct and the duodenum. The liver was normal, but the spleen was enlarged from obstruction of the splenic vein. The body of the pancreas was similarly enlarged from obstruction of the pancreatic duct, but the cholecyst-duodenostomy was patent, and the gastro-jejunostomy was normal. The veins in the great omentum, falciform ligament and especially those running from the duodenum to the gall-bladder, over the old anastomosis, were enormously enlarged to establish a collateral circulation. The anastomosis between the great omentum and the anterior abdominal wall was similarly dilated. I fear the outlook is very bad.

I think your original diagnosis of growth at the head of the pancreas, or of the common bile-duct, must have been correct, and that probably the radium treatment delayed the progress of the disease.

Captain H. died shortly after this operation.

This case supplies irrefutable evidence of the temporary disappearance following radium treatment of all signs of carcinoma when the pancreas was palpated during a second laparotomy. The subsequent recrudescence of the growth excludes the possibility that my original diagnosis might have been erroneous.

From an evidential point of view the case is thus more important than the cases where no return of the growth has taken place.

*CASE II.—Vaterian carcinoma with nodular extensions into the pancreas, associated with gall-stones. Radium treatment of the carcinoma, removal of gall-stones. Cholecyst-duodenostomy. Patient well nearly fourteen years later.*

Jane B., a married woman of fifty-five, was sent into my ward at the Middlesex Hospital September 25, 1920, by Dr. H. Campbell Thomson. For five or six years she had been subject to sudden acute attacks of right hypochondriac pain, passing round to the back, and occurring on the average about every three weeks, and lasting from a few hours to a whole day. The attacks were generally accompanied by vomiting and shivering. During the attacks she had noticed that the urine was dark, though her motions were unaltered in color.

The last severe attack occurred three weeks before admission, but there had been two subsequent mild ones.

She had never suffered from jaundice, and was not jaundiced on admission—a rather important fact, since it negatives the suggestion of impacted calculus in the common duct which might otherwise be made.

## RADIUM TREATMENT FOR PANCREATIC CANCER

September 27, 1920, I opened the abdomen by a right paramedian incision about six inches in length. The gall-bladder was found to contain stones.

Upon feeling the surface of the pancreas a number of hard nodules like secondary nodules of carcinoma were felt, and further search revealed a primary growth in the posterior wall of the second part of the duodenum in the situation of the orifice of the common bile-duct.

The fundus of the gall-bladder was incised and about fifty gall-stones were removed with a spoon. A cholecystoduodenostomy was then performed so that later if the duodenal growth occluded the bile-duct, bile should still be able to reach the duodenum.

A tube of radium, 45-mg. element, with a 1-mm. platinum screen, fixed on the end of a stout silver wire was introduced behind the duodenal growth after mobilization of the duodenum by a vertical incision through the peritoneum at the right margin of the viscus. The wire of the radium tube projected from the sutured incision, and the tube was removed in fifteen hours.

The patient made a good convalescence and was discharged twenty-three days after the operation. For two and one-half years she remained quite well, but about March, 1923, she again began to suffer from pain in the right hypochondriac region, passing round to the right scapula, coming on gradually, becoming acute, associated with vomiting, and passing off in about two and one-half hours though shivery feelings lasted another hour. In May, 1925, she noted pain in the back, passing down to the legs, during the attacks. The attacks became more severe and frequent, and November 24, 1925, she was again admitted under my care. She was stated to have recently lost forty-two pounds in weight. Morphia injections had been necessary during the attacks. During an attack six weeks before readmission she had noticed herself yellow and the stools light in color.

It was thought that the attacks indicated temporary obstruction of the cholecystoduodenostomy opening, and operation was considered unnecessary. She was discharged December 16, 1925. She was again admitted May 19, 1926, almost in a state of collapse, and for the first time the notes record jaundice. Nothing was done surgically, and she left the hospital June 12, 1926.

March 29, 1928, I saw her again. She was perfectly well, free from pain, and putting on weight, having gained twenty and one-half pounds during the previous twelve months. She remains well at the present date (March, 1934).

CASE III.—*Carcinoma of pancreas with distention of gall-bladder. Radium and cholecystgastrostomy. Death.*

Mr. R., aged about seventy, failed in health in September, 1929. Vomiting, abdominal pain and jaundice were the principal symptoms, with pyrexia up to 102. The liver was unduly palpable. Occult blood and free fatty acid were present in the stools, and a provisional diagnosis of cancer of the pancreas was made. October 29 I explored the abdomen and found a distended gall-bladder and a large hard mass in the head of the pancreas. There was a scarred and contracted area of peritoneum on the under side of the transverse mesocolon, so that evidently the growth had infiltrated widely. Cholecystgastrostomy. Two 25-mg. tubes of radium were introduced into the substance of the tumor from below the mesocolon for twenty-four hours. The condition of the patient did not permit of a gastroenterostomy. Death from asthenia in forty-eight hours.

CASE IV.—*Carcinoma of bile papilla. Exploration. Radium treatment. Death.*

Mr. B., aged eighty-two, first seen January 7, 1928, had suffered for some weeks from severe epigastric pain, with tenderness and a doubtful thickening in the duodenal region. The diagnosis was cholecystitis, but abdominal fat precluded effective palpation. An exploratory operation showed a lump one inch in diameter at the end of the common bile-duct, and involving the pancreas. Through the anterior wall of the duodenum the crater of the ulcer could be felt in the situation of the bile-papilla. After division



W. SAMPSON HANDLEY

of the posterior parietal peritoneum to the right of the duodenum a drainage tube was introduced into contact with the outer aspect of the lump. Two 25-mg. radium tubes were left in the drainage tube for twenty-four hours. A very cautious prognosis was given in view of the age and condition of the patient. Three days after operation the patient died "for no apparent reason." A necropsy confirmed the diagnosis of carcinoma. The pathologist reported as follows: The two portions of tissue removed from the pancreas were sectioned. Histologically the features are those of a carcinoma. The growth is composed of hyperchromatic cells which resemble the parenchyma of the pancreas but the nuclei take up a relatively large proportion of the cell and the alveoli are irregular. There is some hyperplasia of the islets.

CASE V.—*Carcinoma of head of pancreas. Operation. Radium treatment. Death ten days later.*

James N., aged fifty-eight, was admitted to the Middlesex Hospital under my care in March, 1930, with a history of two month's jaundice. Upper paramedian laparotomy disclosed a localized hard mass in the head of the pancreas. Tubes of radium totalling 21 mg. were inserted in the end of a drainage tube which was placed in contact with the mass. A cholecystgastrostomy was then performed. The patient died ten days later without any symptoms except increasing weakness. A necropsy showed a carcinoma of the pancreas invading the duodenum and occluding the bile-duct.

CASE VI.—*Carcinoma of pancreas. Laparotomy. Insertion of radium tubes. Twenty-five days later gastroenterostomy for pyloric obstruction. Death two days later.*

William H., aged fifty-four, was admitted to the Middlesex Hospital under my care in November, 1928. For two years he had suffered from pain in the epigastrium with loss of appetite and weight. Upper paramedian laparotomy. A hard mass was felt in the head of the pancreas. A portion removed for section showed only chronic inflammatory changes. Three 25-mg. tubes of radium were pushed into the mass and were left for twenty-four hours. Twenty-five days later signs of pyloric obstruction necessitated a gastroenterostomy, but the operation proved too much for the patient's strength and he died in forty-eight hours. Post-mortem, a large ulcer three-quarters inch in diameter was felt in the first part of the duodenum. The second part of the duodenum was involved in a large polypoid colloid growth infiltrating the head of the pancreas.

CASE VII.—*Carcinoma near end of common bile-duct, with wasting and epigastric pain. Radium operation. Patient at work and free from symptoms ten months later.*

Mr. D. S. N., aged sixty-four, was first seen in June, 1933, complaining of loss of weight for a month with spasmodic pain in the epigastrium, not definitely related to the ingestion of food. Vomiting, constipation and jaundice absent. On X-ray examination the stomach was large with marked intermittent pyloric spasm and considerable delay in emptying. Six and three-quarter hours after ingestion of barium a residue remained in the stomach and a well-marked fleck residue still later.

June 22, 1933, the abdomen was opened by diathermy through a right paramedian supra-umbilical incision. The stomach was normal, but the first and second parts of the duodenum were dilated. The gall-bladder was not distended. A cystico-omental band crossed the duodenum and was divided. The pylorus was normal and no sign of an ulcer was found either above or below it. Three inches below the pylorus and behind the duodenum was a puckered hard mass, about two and one-half inches in diameter, evidently a carcinoma originating at the end of the common bile-duct. The duodenum was mobilized by an incision through the peritoneum at its right border, and nine 2-mg. tubes of radium element enclosed in a glove finger were inserted on the posterior aspect of the growth and in contact with it and were left for fifty hours.

The question of a cholecyst-gastrostomy and a gastroenterostomy was considered, but the anæsthetist reported that the patient's general condition was bad, and neither operation appeared necessary at the moment. It was thought that one or both operations

## RADIUM TREATMENT FOR PANCREATIC CANCER

would be required later after a period of improvement which might last two or three years.

Mr. N. was seen again in January, 1934. He states that he feels very well and that his only trouble is constant flatulency, but this is no worse than it has always been through his life. He can take any food in reason and is sleeping well. Since the operation he has gained fifteen pounds. Pulse soft and regular, perhaps rather deficient in volume. Patient had much pain before the operation but now has none and feels well and able to do a full day's work. On examination his stomach was perhaps a little splashy, but is high up and not dilated. There is no present indication for a gastro-jejunostomy (January 6, 1934).

This patient's medical man, Doctor Farquharson, reports as follows on April 8, 1934:

I saw Mr. N. a few days ago and as far as I could judge he is going on very well. He has put on weight and the only trouble seems to be marked flatulence; some of this I think is due to his leaving off his alkaline powder. He has no glands and I cannot feel his liver, his color is good and he is carrying on his work.

The flatulence which at present is the patient's only symptom may indicate that some stenosis is developing in the duodenum and that a gastroenterostomy will be necessary later on.

*Results of Radium Treatment.*—Of the seven cases of carcinoma of the pancreas recorded in this paper one remains cured after a period of nearly fourteen years. The presence of isolated nodular deposits outside the main mass at the time of operation made the diagnosis in this case as certain as it could be without a biopsy. The removal of a piece of the growth for section involves a grave additional risk which in this case, and as a rule, appears unjustifiable.

In a second case life was prolonged for over two years, although according to Robson and Moynihan the whole clinical course of pancreatic carcinoma is run as a rule within twelve months. Furthermore, at a second laparotomy, necessitated by pyloric obstruction, all signs of carcinoma had disappeared, following the radium treatment. The growth later resumed its activity and was found at the necropsy.

In a third case the patient remains well ten months after radium treatment, a period long enough to justify the assertion that radium has imposed a definite check to the growth, but too short to justify any confident hope that the growth is cured.

In the remaining four cases death occurred within a short period of the laparotomy, apparently from simple asthenia, a mortality of 57 per cent. It must be admitted that this is a high and discouraging mortality. These patients are generally advanced in years, and have been suffering perhaps for months from malnutrition, the result of vomiting and frequently from jaundice. I do not think that radiation has anything to do with the mortality, though it might be advisable in future cases to screen the right supra-renal capsule by a lead screen covering the posterior aspect of each of the radium tubes.

A comparison between the results of palliative operations in which no radium is used, and my own results, confirms the conclusion that the high mortality is due to the unsatisfactory general condition of the patients and

W. SAMPSON HANDLEY

not to radiation. According to Gosset the mortality of simple cholecystostomy for pancreatic carcinoma is 70 per cent., and of cholecystenterostomy 75 per cent.

Under all the circumstances it may I think be claimed that my results are encouraging. Interstitial radium in pancreatic carcinoma appears to hold out a one in seven chance of permanent cure, and a three in seven chance of prolonged relief.

*Conclusions.*—It is one of the difficulties of the surgery of relatively rare conditions that the individual's experience, even in a lifetime, may be too limited to warrant the expression of firm conclusions. My essays in the radium treatment of carcinoma of the pancreas, though they extend over thirteen years, leave me in this unsatisfactory position.

My material is of suggestive rather than demonstrative value. The conclusions I have arrived at are provisional and subject to correction by further collective experience but they will serve to define the outline of an unexplored subject and to form a baseline from which other workers may start. Owing to difficulties of diagnosis and the comparative rarity of pancreatic carcinoma, the subject is essentially one for collective investigation, preceded, if possible by the general adoption of an agreed plan of action. With these qualifications I shall state my personal conclusions in dogmatic form.

Carcinoma starting in the ampulla of Vater if detected early as a small nodule at the outlet of the bile-duct may be dealt with by opening the duodenum and doing a limited intraduodenal ablation of the growth by diathermy. It will usually be wise to do a cholecyst-duodenostomy to avoid cicatricial stenosis at the orifice of the common duct.

All other forms of Vaterian cancer can be more hopefully treated by implanted radium than by ablational operation. Although ablational operations may win a rare and splendid triumph as in a case of my colleague Gordon-Taylor they lie at the limits of the patient's endurance and the surgeon's skill, and their mortality will always remain very high. Moreover, they are only exceptionally practicable.

In using implantation radium treatment it must be recognized that even if the growth be completely fibrosed by radiation its obstructive effects upon the bile-duct and upon the duodenum may be actually aggravated by cicatrization. After the surgeon has divided the posterior parietal peritoneum to the right of the duodenum, mobilized the duodenum, and introduced radium tubes into close contact with the posterior aspect of the growth, logic demands with an eye to the future that he should anastomose the gall-bladder to the duodenum and then should do a gastroenterostomy. I say logic demands this, but the general condition of the patient may make it advisable to postpone the gastroenterostomy, or even (in the absence of jaundice) also the cholecyst-duodenostomy.

What is the optimum dose of radium in pancreatic cancer? Provisionally I would put it at 700 to 1000 mg. hours. This statement is ambiguous since

## RADIUM TREATMENT FOR PANCREATIC CANCER

it gives no time-intensity ratio. Should a large quantity of radium be used for a short time, or a small quantity for a longer time? Experience in cancer of the tongue has shown that the employment of small power tubes inserted for a week is far more effective than the use of large tubes for a day. In using a group of 2-mg. or 3-mg. tubes in the retroperitoneal tissues there might be a risk of a persistent sinus if the tubes were left as long as a week. Nevertheless, it is, I think, in this direction that hope for the future lies. I propose in future cases to use perhaps three tubes each of 2-mg. element, and to remove them after five days, giving a total dose of 720 mg. hours.

In any case I prefer to use radium rather than radon. The intensity of radon tubes is initially uncertain, dependent as it is upon the hurried observation of a laboratory technician. The rapid fall in intensity of a radon tube appears in any case to be an undesirable factor.

In conclusion my experience justifies the statement that a surgeon who on opening the abdomen finds an irremovable pancreatic cancer is not doing his duty to the patient unless he subjects the growth to interstitial irradiation.

## SURGERY IN SYRIA

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THE birth of the ANNALS OF SURGERY and its predecessors, *The Annals of the Anatomical Society* and *The Annals of Anatomy and Surgery*, mark the birth of the recent renaissance of medicine and surgery in Syria.

It will be remembered that it was chiefly the Syrian scholars who translated and transmitted to the East the medicine and teachings of the Greeks and early Romans, and it was the Syrian and Arab scholars who improved on and transmitted back to the West that same medicine. They were the custodians who received and kept aglow for several centuries the torch of learning during the period when Europe was in its dark ages, and who gave back to Europe that same torch more brilliantly illumined. They, themselves, then fell back into their dark age.

For several decades prior to 1870, the art of healing in Syria was conspicuous by its absence. A very few of the larger cities had one or two doctors each—either army medical officers or foreign missionary doctors—while the majority of the cities, towns and villages had none. The population had to depend on the barber for the annual vernal venesection, the opening of abscesses and the pulling of teeth, and upon the goatherd for the treatment of fractures and dislocations. In each village or town there was the sheik or the priest or an elderly man who knew something of medicine, such knowledge being transmitted from father to son or gleaned from a greatly boasted-of pharmacopœia, corrupted remains of the old Arabian teachings. The only operative work, which was mostly of a minor nature, was done by the army surgeons or one of the doctors of the foreign mission boards. There were plenty of quacks who dispensed some secret herbs, mostly diaphoretics, laxatives and expectorants, and their ministrations gave birth to the well-known Arabic proverb, "If the patient lives it is from Allah and if he dies it is from Abd Allah (servant of God)".

Soon after the invasion of Syria by Ibrahim Pasha—son of the renowned Mohammed Ali Pasha of Egypt—which took place about 1835, the Pasha started sending four bright Syrian young men to the Kasr-el-Aini Medical School of Cairo. This did not last long as Ibrahim Pasha was forced back to Egypt by the combined efforts of the Turkish Army and the British Fleet.

At about the same period the American Board of Foreign Missions started sending missionary doctors to Syria and Palestine. The first was Dr. Asa Dodge, who came to Jerusalem in 1833 and practiced until 1835. Soon after that Cornelius V. A. Van Dyck (1839), Henry A. de Forest (1842) and George E. Post (1863) were sent out.

Such was the state of affairs when the American Mission stepped into



## SURGERY IN SYRIA

the gap and founded the Syrian Protestant College of Beirut in the year 1866, and in 1867 started the medical school under the supervision of Drs. Van Dyck, Post and Wortabet. The first class of six students was graduated in 1871 and were the first regularly trained physicians that ever graduated from a regular medical school in Syria. The graduates of this school (which is now known as the Medical School of the American University of Beirut, having its own board of trustees in New York City and registered under the laws of the State of New York) number over 800. They have fulfilled an urgent need not only in Syria but in the whole Near East—Palestine, Mesopotamia, Turkey, Armenia, Greece, Egypt and the Sudan. They have been of the greatest aid to the British in the sanitary reconstruction of Egypt, the Sudan, Palestine and Mesopotamia.

A few years later—in 1883—the French Medical school was founded in Beirut and its hundreds of graduates have been a great source of light in getting rid of quackery and charlatanism, and have also given Syria and the Near East the blessings of the noble art of healing. In 1912, another medical school was opened in Damascus, especially for the benefit of the men who had no knowledge, or poor knowledge, of any foreign language, and this school is forging ahead and helping the interior of the country. They are also following the paths of their grandsires in translating into Arabic the best French, English and German medical books.

The work of the early teachers of both the American and French schools laid a solid foundation on which the recent marvelous advances have been made. With no laboratory facilities, no proper nursing, poorly equipped schools and hospitals, the fact that teaching had to be done in Arabic with no text-books and no reference books—the language of instruction was Arabic until 1889—these men labored like Trojans and accomplished a remarkable amount of work. They had to fight and surmount the superstitions of centuries, quackeries, religious bigotries, fear of foreign influences, eccentricities of the old Turkish government, *etc.* The work of Van Dyck on the eye, his translations and writings of the first and only scientific books in Arabic, not only in medicine but in chemistry, physics, geology, astronomy and even Arabic poetry; the work of Post on botany and on urinary calculi and lithotomy; the work of de Brun on malaria; the work of Graham on dengue; are all classical.

The first regular hospital to be founded in Syria was the Johanniter Hospital which was established in Beirut in 1860 as a direct result of the massacres of that year. It was supported by the Knights of St. John of Berlin and run by the Kaiserswerth Deaconesses. In 1871, the medical management of this institution was entrusted to the American professors of the Syrian Protestant College, a very happy relation that continued until the United States declared war on Germany, when this happy relation reluctantly came to an end.

Gradually several institutions were opened in the different cities in Syria and Palestine under the auspices of the various religious missions: American, English, Scotch, Danish, French, German, Italian. These institutions with

their limited capacities and facilities did a great deal of noble work for the alleviation of suffering and the cure of disease.

Today Syria boasts of several up-to-date, completely equipped institutions. The American University—thanks to the generosity of the Rockefeller Foundation—is equipped with excellent biochemistry, pathology, pharmacology and research departments, as well as other school and hospital facilities. The French University is well equipped with a radium and deep X-ray therapy institute as well as a rabies institution. Several well-equipped private laboratories and X-ray and electrotherapy establishments are found in every large city and medicine has at last been put on a regular scientific basis. Syrian doctors feeling the need of specialization and post-graduate work have been visiting the various centers in Europe and America. Thus the practice of medicine in Syria has been elevated to a high standard. A few medical periodicals are now being published in Arabic, and the physicians, instead of being mere copyists, are now recording their own personal experiences, thus adding to the medical literature.

The purpose of this paper is to give a general idea of surgery in Syria and the special local problems that we have to face. With better laboratory and diagnostic aids we often meet with especially interesting and rare cases, but in the following paragraphs we can discuss these only in a general way.

*Special Problems in Syria.*—Syria, having such a variety of climates, ranging from the subtropical at the sea level to the temperate and cold at the mountain peaks 11,000 feet high, shows a variety of diseases. Several of these are peculiar to, or abound in this section of the Mediterranean, such as Aleppo button, dengue fever, Malta fever, malaria, typhoid, dysentery, etc. Many of these are endemic in the country and often assume epidemic forms.

Due to these existing conditions several surgical diseases predominate in the country. Amoebic liver abscesses, hydatid cysts, chronic affections of the gall-bladder, herniæ, urinary calculi, seem to be more prevalent in Syria than in most other countries. The first question asked of a doctor practicing in Syria is "what do you know about urinary calculi"! for with India and China Syria boasts of more "stones" than most of the other countries.

Until very recently patients had a dreadful fear of hospitals and hospitalization and a hospital was considered as a last resort where they came to die. Hence the great delay in calling for medical help. We seldom see a case that has not suffered for a long time before consenting to come to a hospital, and most of the patients come to us in an advanced condition. Another difficulty is the impossibility of following up these cases. Once they go back to their villages and towns or to the desert, they are lost to the world, and so it is difficult to evaluate one's work.

Due to poverty, limited hospital bed capacities, and the large number of patients needing hospitalization, chronic cases cannot be kept for the length of time necessary. Many of them do very well while in the hospital and are discharged in greatly improved conditions, to come back in a few months in a pitiful state.

## SURGERY IN SYRIA

*Urinary Calculi.*—A great deal of research work has to be done before we can determine the actual cause or causes for the great prevalence of urinary calculi in Syria. I doubt if there is any special cause—such as the bilharzia in Egypt—to account for that, except that all the known factors for the formation of calculi are present and in a marked degree. Thus stasis, bacterial infection, hard water, poor diet and faulty metabolism, mechanical factors, focal infections, poor hygiene, *etc.*, are all factors that are too common in Syria. Some observers consider that sweating is a contributing factor, but there are many other countries that are hotter and damper and that do not show such a prevalence.

My personal belief is that though there are many cases of urinary calculi, their frequency has been greatly exaggerated. While hundreds of cases have been reported from Syria, China and India, it must be remembered that the men who reported these had an unusual chance of seeing and operating

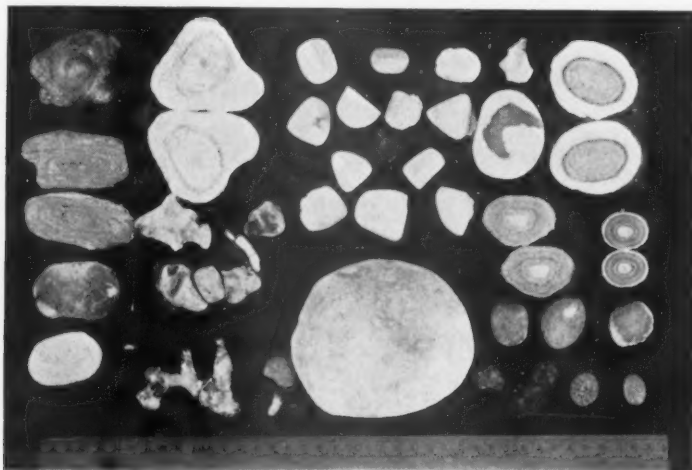


FIG. 1.—A few of the calculi of the G. E. Post collection. Note the preponderance of vesical calculi.

on them. They were the only surgeons in those parts and probably saw the majority of cases that were to be seen in the country. Thus I know that my old professor, George E. Post, was the only surgeon in Syria, at that time, and must have seen at least 80 per cent. of the cases that existed in Syria, Palestine and the immediate countries of the Near East. The same is true, I suppose, of the few surgeons in India and China who have reported so many cases.

The above is a photograph of a very small part of Post's "quarry." All kinds of calculi are seen, but there seems to be a high percentage of vesical calculi which often attain a considerable size on account of neglect. The calculus in the middle of the photograph is eleven and one-half centimetres in diameter. Kidney stones are also very common and often attain a considerable size. Nephrectomy is the rule as most of the patients coming for operation show a marked destruction of the kidney tissue on account of neg-

lect. No age is exempt. The youngest case we have on record is six months old and the oldest eighty-five years.

*Liver Abscesses.*—We believe that the term solitary liver abscess—pertaining to amœbic abscesses of the liver—is often a misleading term, as in our experience the abscess is multiple in a large number of cases. This probably explains the frequency with which these abscesses were supposed to recur after operation, as what probably recurs is not the abscess that was drained but another that was overlooked. Happily, we do not see as many cases now as we used to see in the past, possibly because of our better understanding of the disease and an early diagnosis and efficient treatment.

Amœbiasis is quite a problem in Syria. Routine examination of the stools—especially by the concentrated method after a laxative—shows a great many people harboring the amœba in their intestines.

There has been a great deal of controversy as to the treatment of this

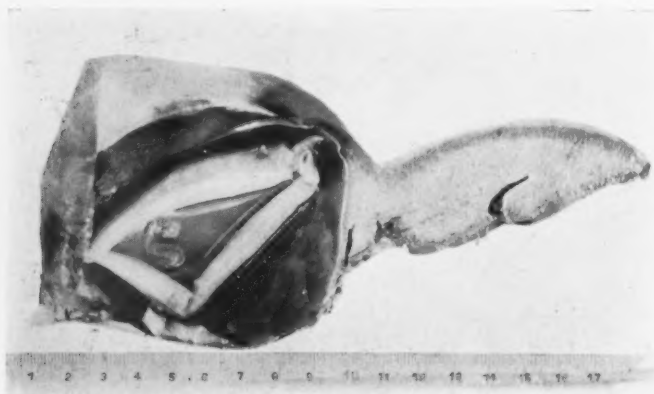


FIG. 2.—Hydatid of the spleen. (Courtesy of Dr. S. I. Haddad.)

condition. Physicians insist that it is a purely “medical” disease to be treated by emetine and aspiration, and “surgeons” insist on opening and draining these abscesses. In the early and uncomplicated cases there is no doubt that aspiration and emetine give us satisfactory results and our policy has been to follow that line of treatment in the early and uncomplicated cases, reserving opening and draining for the more advanced ones and for those with secondary infections. In Syria, where suppurating hydatid cysts are not very rare one must be careful in not mistaking them for amœbic abscesses.

*Hydatid Cysts.*—During and soon after the World War there was a bad outbreak of echinococcus infections, especially among the refugees. People were turned out of their homes and drifted about homeless, penniless, and naked, living on almost anything they could find—dogs, cats, grass, remnants of food, in fact anything they could chew. Most of them were farmers and had a great deal to do with sheep and dogs.

There is no part of the body that is safe from the ravages of the echinococcus. It has been found in the liver, spleen, lungs, brain, muscles, kidneys, mesentery. Many cases go unnoticed and cause no symptoms during life

## SURGERY IN SYRIA

only to be discovered in the post-mortem room. Many of these have been absorbed, leaving behind nothing but a calcified nodule the remains of an obsolete cyst.

It is interesting to note that many of these cases come in very late and are suppurating, thus being diagnosed as liver abscesses. Blood examination in the non-suppurating hydatids shows very little change except possibly a mild anæmia and an increase in the number of eosinophils. In our experience the Weinberg test has not proved very satisfactory. The Casoni test seems to be more reliable and gives results in about 70 per cent. of the cases. Most of the patients complained of the presence of a mass which caused slight pain from pressure. A distinct hydatid thrill was elicited in several cases.

A large majority of the cases are marsupialized. Antiseptics are used in



FIG. 3.—Chronic cholecystitis and cholelithiasis. Gall-bladder walls two metres thick.

most cases—formalin, tincture of iodine, carbolic and alcohol. In the small cysts, after the removal of the walls, the cavity was filled with normal saline solution and closed. This in time becomes absorbed and the cavity obliterated.

Turner, Berberian and Dennis of the American University of Beirut have been doing some experimental work on interrupting the life cycle of the *tænia echinococcus* by means of artificial immunization. Their conclusions are that it is possible to induce a marked degree of resistance to the *tænia* infestation in dogs.

*Chronic Cholecystitis.*—After my return, last year, from a long sojourn in the United States, I was struck by the large number of chronically diseased gall-bladders. With repeated pregnancies, prevalence of typhoid, dysentery, malaria, intestinal and focal infections, sedentary habits, it is not strange to find so many cases.

Most of the cases operated on by us last year showed very thick walls and a good deal of pericholecystitis. In one case from which four large and a hundred small calculi were removed the walls were  $1\frac{1}{2}$  centimetres thick.



In another case, pictured above, the walls were 2 centimetres thick and so hard that no stones could be felt in the gall-bladder.

About 30 per cent. of our cases gave a history of typhoid, but in none were we able to find Eberth bacillus. Most of the cases showed the bacillus coli. In our cholelithiasis cases the blood cholesterol was not increased, being just high normal.

*Herniæ.*—There are few countries that have as many hernia cases in proportion to the population as Syria. Patients neglect themselves too long until they develop enormous herniæ before they come for relief. The chief cause is the use of human power instead of mechanical power. It is a familiar sight to see a "human truck" carry a load of five hundred pounds and trotting along as if on a picnic.



FIG. 4.—Types of hernia often met with.

A large number of cases come in with multiple herniæ. Out of thirty cases operated on last year, twelve had double inguinal, three femoral and umbilical, one umbilical and inguinal, and two double femoral. There are a large number of recurrences, mostly due to the patients having to go back to their old vocations and habits. Many recurrences are due to post-operative infection. The skin over these herniæ is thick, unhealthy, swollen and feels like parchment from the repeated cauteries applied for a cure. It has been our pol-

icy to hospitalize these cases for a few days prior to operation, to reduce the swelling and put the skin in a healthier condition.

*Surgical Tuberculosis.*—This is a condition that was very prevalent in Syria. With better hygiene, early diagnosis and treatment and the establishment of sanatoria, this is now on the decrease.

Tuberculosis of bone is still very prevalent and is quite a problem as it is impossible to keep patients in a hospital for several months. They are discharged in greatly improved conditions but come back a few months later with draining sinuses and mixed infections. Syria is blessed with excellent weather and bright sunshine for at least eight months of the year, but this asset is greatly counterbalanced by the lack of proper hygiene and good food.

In our work we are depending more and more on the conservative treatment of these lesions and our results have been more gratifying. In lung and peritoneum tuberculosis a great deal of work is being done with artificial pneumothorax, pneumoperitoneum and phrenectomy with good results.

In conclusion, it is right to state that Syria owes a very great debt to America and France for the recent revival of medicine and surgery.

## RETROPERITONEAL CYSTS

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FROM THE LAHEY CLINIC

MESENTERIC, omental, and retroperitoneal cysts must actually be grouped in the same category since the mesenteric and omental variety are merely an anterior extension, or inclusion, of those originally retroperitoneal. The distinction is a clinical one, based on location, and consequently, on possible symptomatology. Pathologically and embryologically they are alike and can actually be classed as retroperitoneal cysts.

In order to comprehend the "true" retroperitoneal cyst we may follow the definition of Handfield-Jones,<sup>1</sup> that they are "those cysts lying in the retroperitoneal fatty tissues which have no apparent connection with any adult structures save by areolar tissue". They may spring from any one of the three germinal layers and while those from the ectodermal and endodermal elements may be classed as dermoids,<sup>2</sup> the mesodermal ones cannot, in the true sense of the word. These latter have, however, been called mesodermoids.<sup>3</sup>

The classification of these cysts has been suggested by many of those who have written in the fairly extensive literature on the subject. We propose the following fairly simple one, which, we believe, includes all the varieties.

(1) Wolffian cysts, the most interesting and important group, arising from persistent remnants of any part of the early urogenital system.

(2) Lymphatic or chylous cysts, from developmental or obstructive phenomena of the retroperitoneal and mesenteric lymphatic system, lined merely by fibrous tissue, or occasionally by endothelium.

(3) Dermoid cysts, from imperfect closure of the abdominal plates, or from strayed genital cells (Felix) or supernumerary ovaries.<sup>1, 4, 5</sup> Included under this heading are the enteric cysts or enterocystomas,<sup>4</sup> the endodermal parallel of the dermoid, formed by inclusion in the mesentery in embryonal life of a diverticulum of the intestine or of a closed-off portion of the vitelline duct.

(4) Mesocolic cysts, described by Handfield-Jones,<sup>1</sup> from pockets of peritoneum left between the opposed serous surfaces of the mesentery and parietal peritoneum in the early rotation of the colon from the left to the right. These cysts are necessarily within the three-sided square formed by the colon.

(5) Parasitic and inflammatory cysts, notably those of the echinococcus and of broken-down tuberculous lymph-nodes.

(6) Traumatic blood cysts, a self-explanatory class.

As previously stated, cysts of the kidney, suprarenal, and pancreas are not true peritoneal cysts.

An explanation of the development of the Wolffian cyst requires a statement of the detailed embryology of the urogenital system. It is sufficient to mention that the pronephros, the first step in its development, is rudimentary and its tubules are scattered all along from the second to the thirteenth body segment. It completely disappears very early. The mesonephros develops from the mesoderm of the intermediate cell mass, and growth extends up and down, reaching from the sixth cervical to the third lumbar segment. All of these tubules degenerate except the three caudal segments. The metanephros

develops from the caudal quarter of the nephrogenic cord, and most of it goes to the formation of the permanent kidney. The Wolffian duct is the excretory duct of the pronephros and mesonephros and forms the tubular part of the genital system in the male. The Mullerian duct, which forms medial to the Wolffian duct by invagination of the coelomic mesothelium, forms the internal genitalia, except for the ovaries, in the female; and it, as well as the Wolffian duct, empties into the cloaca. The ovary and testes develop from specialized mesothelial cells overlying the surface of the Wolffian body toward the median plane.<sup>1, 4, 6, 7</sup> (Fig. 1.)

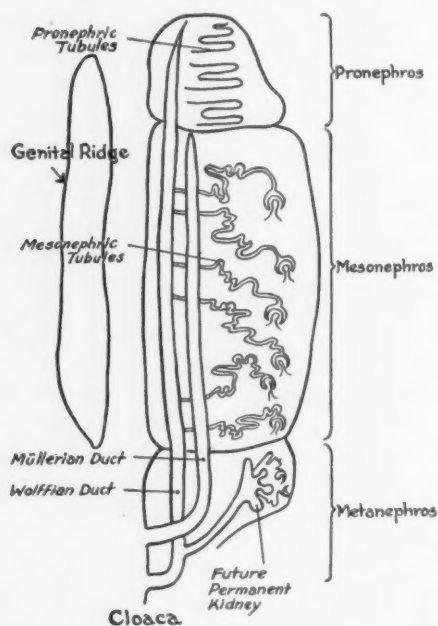


FIG. 1.—Schematic diagram of the early development of the urogenital system.

female, and most of the Mullerian, in the male, there are many possibilities for cyst formation. Practically all Wolffian cysts have been found in women because of this utilization of the Wolffian duct in the formation of the male genitalia.

General or local enlargement of the abdomen is the usual complaint of the patient with a retroperitoneal cyst, or the tumor may be found on routine physical examination. Rarely do these cysts cause pain by pressure on nerves. They often displace the colon, ureters or kidneys, but it is extremely infrequent that they obstruct either the ureter or bowel. In this respect, they are unlike the mesenteric cysts, which from their location are prone to cause intestinal obstruction.

Complications of mesenteric cysts stated by Higgins and Lloyd<sup>8</sup>—intestinal obstruction, peritonitis, hæmorrhage, rupture, torsion, impaction in the

## RETROPERITONEAL CYSTS

pelvis—are all rare in those behind the posterior parietal peritoneum. Stoney<sup>9</sup> reports one which developed an acute inflammatory process, but even this is unusual.

Stewart,<sup>5</sup> from two of his cases in which there was displacement of, and pressure on, the ureter and colon, stresses the importance of pyelography and the barium enema. In his cases the findings were very marked—more marked than is usual. The great importance, however, of the above two measures in the diagnosis of retroperitoneal cysts is in ruling out disease in the kidneys, ureters, or colon, for it is essentially by making sure that the abdominal organs are normal that we diagnose the retroperitoneal cyst—a diagnosis of exclusion. Nevertheless, we can suspect such a condition in a patient with an essentially asymptomatic, soft, rounded, fairly fluctuant abdominal tumor, which, if in the region of the kidney, can be felt well in the flank, or by bimanual examination. Moynihan<sup>10</sup> suggests in the diagnosis of the mesenteric cyst that they are generally near the umbilicus, very mobile, especially in the transverse direction, and surrounded by a zone of resonance with occasionally a resonant band directly across the tumor. The retroperitoneal variety, on the other hand, are usually in the right or left lateral abdomen and not movable, or only slightly so. Of course, in the diagnosis of echinococcus, tuberculous and traumatic cysts, the history, or the rest of the examination of the patient, may well throw light on the matter.

Pathologically, the Wolffian cysts are of parchment-thin wall and flabby, contain yellow to brown fluid, and are lined with anything from low cuboidal to high columnar epithelium. Cave<sup>11</sup> states that “cysts which are conclusively proven to arise from the Wolffian body show primitive glomeruli and kidney tubules in some place or places in the cyst wall.” While this finding has been present in occasional of the cysts reported, it is not held by the majority to be a requisite for the diagnosis of a urogenital cyst. In some cysts there are papillary projections and in others there is the structure of the multilocular, compound, cystic, ovarian adenoma.<sup>5, 7</sup> There is a chance of malignancy in these latter.<sup>12</sup>

It is difficult to differentiate these urogenital cysts from the lymphatic cysts but the rule may be stated that the lymphatic cysts are usually without any epithelium unless it be flat or low cuboidal lining in several areas. The chylous lymphatic cysts can be diagnosed by their contents. The dermoids are lined by skin and contain thick sebaceous material and occasionally hair or teeth, while the enterogenous cysts are lined by intestinal epithelium. The suggestion of Handfield-Jones<sup>1</sup> of diagnosing the mesocolic cysts in that they lie anterior, instead of posterior, to the spermatic vessels, is of importance.

Surgically, there are only two methods of dealing with retroperitoneal cysts. Usually, as stated above, these cysts lie free in the retroperitoneal fatty tissue, are unconnected with any other organ, and have no pedicle. Upon incising the posterior parietal peritoneum, or the mesentery of the small intestine, or the mesocolon, as the case may be, it will be found that these cysts are not adherent and a rather easy plane of cleavage can be found so

that they shell out without difficulty. During the course of the procedure, it will usually be necessary only to clamp a few small vessels. Thus, enucleation is simple, and the procedure that can be done in all uncomplicated cases. In, however, those cases in which the patient is a poor surgical risk, or in which the cyst is extremely extensive or adherent, a marsupialization of the cyst wall can readily be done. We have not had to employ this procedure, but it is interesting to note that in the pure lymphatic or urogenital cyst, marsupialization usually produces a cure after drainage for some time. Dermoid cysts cannot be dealt with so readily in this manner from the very nature of their contents and lining.



FIG. 2.—Microphotograph from Case II. This section shows a high columnar epithelium and a fairly dense fibrous tissue stroma, composing the wall of the cyst. This, as stated above, is the typical appearance in these congenital urogenital cysts.

Unless the tumor is in close relation to the kidney and can be readily reached through the lumbar approach, we believe the right or left pararectus incision to be the best. Mere aspiration of these cysts is no longer to be considered an operative procedure of any merit.

We wish to report two interesting cases which have come under our observation, both peculiarly enough, in student nurses.

CASE I.—M. H., a single girl of twenty-one, came to us complaining of a gradually increasing tumor in the right iliac fossa. She had previously had her appendix removed. Examination showed this tumor to be the only abnormal finding, and X-rays showed both kidneys to be in normal position. Operation was performed by Doctor Lahey, through a lower mid-line incision. A retroperitoneal cyst the size of a small grapefruit was removed from behind the cæcum without difficulty. The pelvic organs were normal. Incidentally, a myomectomy was done for a small fibroid as well as a uterine suspension. Following operation, she had a smooth, uneventful course, but four months later had some recurrence of pain in her right lower quadrant, definitely related to menses,



## RETROPERITONEAL CYSTS

however. This soon disappeared and she then continued to be entirely well except for dysmenorrhœa until last seen seven and one-half years after operation.

CASE II.—M. M., a single girl of nineteen, complaining of ache in the right lower quadrant for four months, with nausea and vomiting for five days, some irregularity of her periods and constipation, occasional belching of gas, and a feeling of fullness in the stomach. Examination showed slight right lower quadrant tenderness and an orange-sized, non-tender movable mass in the left lower quadrant. X-ray (Fig. 2) showed the left kidney to be pushed upward by a large left retroperitoneal mass. There was normal

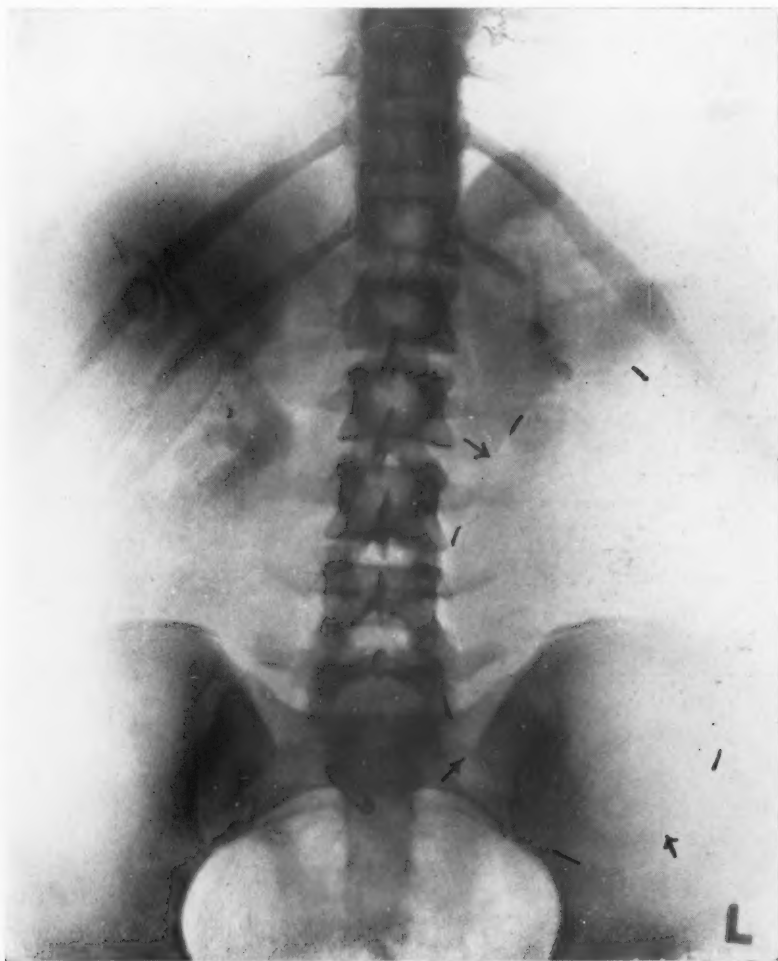


FIG. 3.—X-ray plate of the abdomen in Case II, after the administration of skioidan. Note the displacement upward of the left kidney by the large mass in the left abdomen, which, in spite of its very thin wall, casts sufficient shadow for a great deal of its outline to be defined clearly.

filling of the kidney pelvis with skioidan. Operation was performed by Doctor Clute, through a left rectus incision and a retroperitoneal tumor in the left kidney gutter was found, lying below the kidney and displacing the sigmoid and descending colon medially. Incision was made in the posterior parietal peritoneum laterally and a thin-walled cyst was easily enucleated. Absolutely no connection was found between the cyst and the kidney or any other structure, except for a few minute blood-vessels. The rest of the abdomen was entirely negative, including the tubes and ovaries, which were normal. A

## LAHEY AND ECKERSON

routine appendectomy was done. Examination of this cyst showed it to be fluctuant and transparent and filled with a clear, thin fluid. Its wall was only .2 cubic centimetre thick and very elastic. The pathological report was simple cyst of ovary. (Fig. 3.) The patient had an uneventful convalescence and when last seen a year post-operatively was perfectly well and had had no recurrence of symptoms.

SUMMARY.—(1) A classification of "true" retroperitoneal cysts is given.

(2) The diagnosis can usually be made pre-operatively, and the barium enema and pyelography are great aids in this.

(3) The urogenital cysts are the most interesting of the retroperitoneal variety. Pathologically they are lined with cuboidal or columnar epithelium on a base of fairly dense fibrous tissue, but are thin-walled.

(4) The surgery of the cysts is usually simple—enucleation and marsupialization are the two available procedures.

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## BRIEF COMMUNICATION

### PATELLA BIPARTITA

THIS condition in which the patella arises from two centres, which often fuse, as in the lateral forms, enters into differential diagnosis of affections of the knee-joint. Attention to the condition is often first directed after a trauma.

Four instances have been seen, the first three were the lateral forms, with only secondary masses usually fused with the upper outer border of the true patella. The largest one of these found showed a secondary mass of about  $1\frac{1}{2}$  centimetres in its longest axis with true bone trabeculae and circumscribed margins, fused at one side with the normal patella. All my cases have been diagnosed only after X-ray examination and confirmation.

The last instance of true bipartite patella arising from two centres without fusion was found in a woman, aged forty-six years, married, first examined October 19, 1932. She stated that for ten years she had suffered with a prickling sensation inside the left ankle, accompanied by numbness and a burning sensation with chilliness down the outer side of the left thigh. Her immediate and greatest complaint at the examination was pain all around the left knee which became swollen after use, and much worse at night. She developed hesitancy about going down stairs and had sustained some falls from uncertainty in the action of the left knee which often cracked but had never locked.

Her past history included an appendectomy twelve years, and a panhysterectomy six years, before being examined, the latter operation being followed by attacks of hot flashes relieved somewhat by tablets she had taken. She also has had numbness in her hands which go to sleep when she sits idle and get white around the nail bases. Her husband has a form of neurosyphilis.

The examination showed few noteworthy points—pupils equal and reacted to light and accommodation; heart and abdomen not abnormal except for the scars of operation. Her legs were equal in size and length, patellar reflexes equal and normal. There was no evidence of any form of muscular paralysis or change in skin sensation in the legs.

The left knee seemed enlarged, presenting a hard, bony lump apparently connected with the tibia at the upper outer margin of the tibial tuberosity, lying mostly within the expansion of the patellar tendon and apparently interfering with the action of the tendon and the patella above. There was no effusion in the knee-joint, and the bony mass described was not tender, although she referred her uncertainty in use of the joint and the cracking sensation to this mass and area. Wassermann reaction, negative.

X-ray films (Figs. 1, 2, 3 and 4) of the left knee showed a bony mass about equal in size and equivalent in shape to the normal patella, lying immediately beneath, separated by a well-demarcated hiatus and not apparently intimately connected with it. In the lateral view (Fig. 2) this extra bone was in no way attached to the tibia and its fixation seemed to depend upon its incarceration beneath the expanding fibres of the patellar tendon. A possibility of its origin as a divided or completely separated part of the tibial tubercle, following avulsion and subsequent growth in childhood, as from unrecognized Schlatter's sprain, was considered. A careful survey of the films, however, showed that the whole epiphyseal plane of the tibia running down to the tubercle was composed of normally aligned trabeculae, and there was no evidence of a missing

## PATELLA BIPARTITA

portion of bone or an old hiatus filled up. The outline, size and shape of the extra bone was patently that of the patella and a diagnosis of patella bipartita was made and removal of the extra bone was advised for mechanical relief of her symptoms.

An operation was performed October 24, 1932, at the Presbyterian Hospital. In an ischæmic field an incision five inches long was made external to the patella bordering its outer margin passing down toward the tibial tubercle over the bony mass described. This was deepened through subcutaneous tissue and fat; the spreading fibres of the

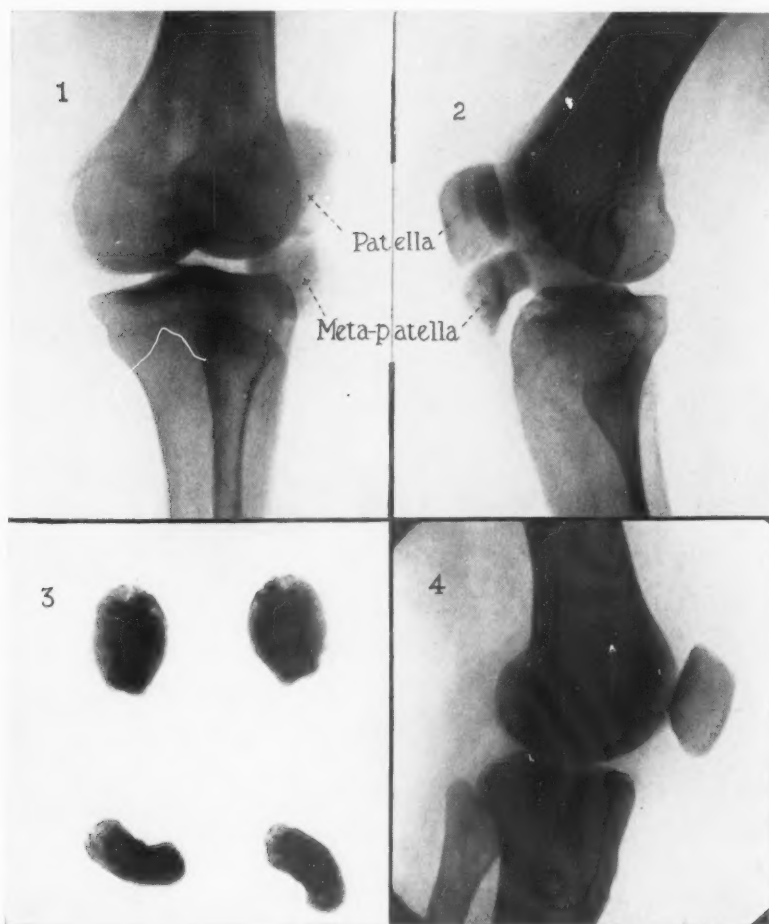


FIG. 1.—Anteroposterior view of the knee showing the shadows of the two patellæ, the metapatella lying at the joint level below the normal patella.

FIG. 2.—Lateral view of the knee showing the two patellæ with a distinct hiatus between them. The metapatella appears to have no bony connection with the tubercle of the tibia and to lie immediately apposed to the joint surface. Its bony consistency is practically equal to that of the normal patella.

FIG. 3.—X-ray of the metapatella removed showing its bony trabeculæ and its rather uniform density with a cartilaginous covering on the joint surface.

FIG. 4.—Lateral view of the knee after removal of metapatella. The contour of the remaining patella and the knee-joint relations appear perfectly normal.

quadriceps tendon were exposed below the normal patella. At a point just at the knee-joint level and extending below it, could be felt the bony mass which was exposed by splitting the aponeurotic fibres overlying it. The bone was then dissected out of its bed by cutting its fibrous connections beneath the tendon. On its anterior surface was found a small bursa and its ultimate delivery was accomplished by grasping it in the



#### BRIEF COMMUNICATION

claws of a towel clamp during the dissection. The true synovial cavity of the knee-joint was not opened in this dissection.

After removal of the bone, the split tendon fibres were sutured together in two layers to close the dead space. The leg was placed in a Thomas splint in full extension. The patient left the hospital November 4, 1933, walking on crutches, not bearing full weight on the left leg. The operative wound was cleanly healed, the left knee not swollen, and there was no excess fluid in the joint.

Within three weeks she was walking without support and with practically a full range of motion in the left knee, all symptoms having subsided.

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